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5

Contents

Plant Sciences

Effect of Drip Irrigation on Growth, Yield and Water Use Efficiency of Sunflower 1
T.Satish Kumar, B.B.Reddy and M.D.Reddy

Contingent Crop Planning for Rainfed Situation in Alfisols of Southern Agro-climatic Zone 5
B.Ravindranath Reddy and P.Sudhakara Reddy

Effect of Weed Management Practices on Growth and Yield of Dry Sown Rice 8
N.V. Lakshmi, Y. Hanumantha Rao and K.Chandrasekhar

Acreage Estimation Studies in Chilli Using Remote Sensing 10
S.S.N. Malleswari, V.C. Patil and T. Ravi Sankar

Weed Management for Efficient Use of Nitrogen in rabi Maize (*Zea mays* L.) 14
K.V.V. Nagalakshmi K. Chandrasekhar and G. Subbaiah

Productivity and Quality of Maize (*Zea mays* L) as Affected by Foliar Application of N and Zn at Flowering 17
M. Aruna, R. Veeraraghavaiah and K. Chandrasekhar

Physiological Parameters of Groundnut as Affected by Moisture Conservation and Fertilization 20
B. Venkateswarlu

Performance of Fodder Maize – Coriander Sequence at Different FYM and Nitrogen Levels 23
B. Hanumantha Rao, B. Venkateswarlu, P. V. N. Prasad and R. Veeraraghaviah

Effects of Salinity on Nitrate Reductase Activity and Proline Accumulation in Desi Cotton (*Gossypium herbaceum* L.) 26
J. S. V. Samba Murthy, S. Ratnakumari and N. Chamundeswari

Correlation and Path Analyses in Maize 29
C Appunu, E. Satyanarayana and T. Nageswara Rao

Correlation and Path Analyses among Floral Characters of Drought Resistant Cultures of Rice 33
S. Vinothini and C.R. Ananda Kumar

Variability, Heritability and Genetic Advance in F_2 Generation of Indian Mustard [*Brassica juncea* (L) Zern and Coss] 35
N.N. Acharya

Correlation and Path Coefficient Analyses of Seed, Plant Growth, Quality and Yield Characters in Rice (*Oryza sativa* L.) 38
P.Bhavana and K.V.Seetharamaiah

Hybrid Vigour of Quantitative and Qualitative Traits in Chilli (*Capsicum annuum* L.) 42
B. Siva Nageswara Rao, V. Chenga Reddy, Razia Sultana, V. Srinivasa Rao and J. Satish Babu

In-Vitro Performance of Two Prominent Sugarcane (*Saccharum officinarum* L.) Varieties 46
A.B. Jadav and S.M. Pawar

Line x Tester Analysis for Combining Ability in Groundnut (*Arachis hypogaea* L.) 49
K. Suneetha, C. Dasaradha Rami Reddy and J. V. Ramana

Application of Proteins as Biochemical Markers for DUS Testing of Rice (*Oryza sativa* L.) Varieties 53
D. Ramatulasi, K.V.Seetharamaiah, C.Panduranga Rao, V.Srinivasa Rao, B.Vijaya Lakshmi

Classical and Restriction Selection Indices in AICSMIP Group of Genotypes of Finger Millet [*Eleusine coracana* (L.) Gaertn.] 61
G.Padmaja, C.Panduranga Rao, V.Srinivasa Rao and P.V.Rama Kumar

Heterosis for Seedling and Field Characters in Rice 66
C. Panduranga Rao, L.P. Yuan and D.H. Huang

Restriction Selection Indices in Roselle(*Hibiscus sabdariffa* L.) 72
Ch.Rani, P.V.Rama Kumar, C. Panduranga Rao and V.Srinivasa Rao

P30822

Cond... 2nd page

Effect of Weather Parameters on the Population Dynamics of *Spodoptera litura* (F.) and *Spodoptera exigua* (Hb.) on Onion 74
Z. Sailaja Rani, D.V. Subba Rao, P. Arjuna Rao, T. Madhumati and V. Srinivasa Rao

External Morphology and Genitalia of Mango Leaf Cutting Weevil, *Deporaus marginatus* (Pascal) (Curculionidae : Coleopetra) 77
J. Manjunath, T. Umamaheshwari and N. Venugopal Rao

Incidence of Lepidopteran Pests of Castor (*Ricinus communis* L.) 80
C. Madhuri, G. Ramachandra Rao, P. Arujna Rao and V. Srinivasa Rao

Bioefficacy of *Bacillus thuringiensis* Ber. as Formulation, Pure Culture and Culture Filtrate Against *Spodoptera litura* (Fab.) 83
T. V. Prasad, P. V. Krishnayya, G. V. Subbaratnam and K. V. M. Krishna Murthy

Effect of Gypsum and Zinc Application on Growth and Yield in groundnut (*Arachis hypogaea* L.) 87
Jayanta Sarkar, T. C. M. Naidu, G. V. H. Rao, G. L. N. Reddy and G. Subbaiah

Influence of Teak Based Agroforestry Systems on the Yield and Yield Components of Groundnut 90
M.Venkata Rao,S.J.Patil and M.B.Chetti.

Social Sciences

Dual Responsibilities of Women Headed Households 93
S. Ratna Kumari and T.R. Rayalu

Cotton a Boon Turned Bane - A Case Study 97
D.Mahitha, P. Venkataramaiah and V.Srinivasa Rao

Opinion and Suggestions on Radio Programmes by the Farmers of Warangal District in Andhra Pradesh 100
G.Sivanarayana, T. Prasantha Kumar and P. Venkataramaiah

Perception of Drudgery of Rural Women in Farm Activities 103
K.Bhagya Lakshmi and P.Venkataramaiah

Constraints Faced by the Growers in Hybrid Rice Cultivation 105
R.K.Raj, A.K. Sahu, Minati Behera and S.Paramguru

Growth Comparisons of Turmeric upto 2020 AD 108
V. Srinivasa Rao and R. Srinivasulu

Research Note

Effect of New Post-Emergence Herbicides on Nutrient Uuptake by Rice-fallow Blackgram [*Vigna mungo* (L.) Hepper] and Associated Weeds 110
Gousia Begum and A.S. Rao

Effect of Different Levels of Nitrogen and Potasium on Transplanted Chilli 112
S. Bharathi and Md. Mujeeb Khan

Variability in Drought Tolerant Rice 114
C.R. Ananda Kumar and S. Vinothini

Genetic Variability and Character Association in Pigeonpea [*Cajanus cajan* (L.) Millsp] 116
D.Satish Kumar, Y.Koteswara Rao, P.V.Rama Kumar and V.Srinivasa Rao

Effect of Different Solid Media on Growth and Sporulation of *Colletotrichum gloeosporioides* (Penz.) Sacc 119
B.Vidya Sagar and A.F.M. Akbar

"SWOT" Analysis of Cotton Cultivation in Andhra Pradesh 121
M. Venkatakonda Reddy and P. Venkataramaiah

Profile of the Jute Farmers of Nadia district of West Bengal 123
Pradipta Acharya, Ch. Ramesh Babu and P. Venkataramaiah

The Andhra Agric. J 53 (1&2):1-4,2006

Journal
Since 1954

Effect of Drip Irrigation on Growth, Yield and Water Use Efficiency of Sunflower

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ABSTRACT

A field experiment was conducted in split plot design with four irrigation regimes – 1.0, 0.8 and 0.6 of Etm under drip and 1.0 of Etm under ridge and furrow (control) method as main plots and three population densities (spacings) – 30 cm x 30 cm, 30 cm x 45 cm and 30 cm x 60 cm in subplots in sunflower crop during summer, on sandy loam soil. The crop under drip irrigation scheduled at 1.0, 0.8 and 0.6 of Etm resulted in significantly higher seed yield (49, 48 and 44%), oil yield and water use efficiency over that of ridge and furrow method of irrigation (control) scheduled at 1.0 of Etm. In drip irrigated plots, field capacity was maintained in the crop root zone through out the crop growth and no stress was observed due to precise and slow application of small amounts of water near root zone at shorter interval. Further, in this system of irrigation, roots concentrated mainly in the upper soil profile and mostly secondary and fine in nature.

Key words: Drip Irrigation, Root Distribution, Spacing, Sunflower, Water Use Efficiency

Drip irrigation in mostly adopted in orchards and high value crops like vegetables as the water is applied precisely at root zone to improve water use efficiency by saving water. It is now adopted in field crops as well due to its advantages and greater incentives given to farmers. However, the information on drip irrigation for sunflower crop is lacking. Further, identification of appropriate irrigation regime for sunflower during summer season in comparison with conventional ridge and furrow method of irrigation is essential. Plant population adjustment by spacings is important for field crops to decrease the initial cost of drip equipment and to place the plants in the limited wetted zone of drip. Keeping the above aspects in view, the following investigation was carried out.

MATERIAL AND METHODS

An experiment was conducted at students farm, College of Agriculture, Hyderabad on sunflower crop during summer, on sandy loam soil having field capacity 17%, wilting point 6.5% and bulk density 1.57 g/cm^3 under drip and ridge and furrow (R & F) method of irrigation. Four irrigation regimes – 1.0,0.8and 0.6 of Etm under drip and 1.0 of Etm under ridge and furrow (control) method formed main plots and three population densities (spacings) 30 cm x 30 cm, 30 cm x 45 cm and 30 cm x 60 cm as subplots (Table 1) were tested in split plot design replicated thrice. In drip irrigation, six groups of three rows of the crop laterally placed in the central row were taken. The drippers were placed to 60 cm apart on the lateral with discharge capacities of 3 liters per hour and irrigations were given as per the treatment at two days interval. Irrigation water requirement (IWR) was calculated using the formula.

IWR (l/Day/emitter)=

$$\frac{\text{Etm x Sr x Sp x Pw}}{\text{IE}} \text{ x N}$$

Etm =Epan x Kp x Kc

Where,

Etm = maximum evapotranspiration

Epan = pan evaporation mean values of last 15 years

Kp = pan coefficient (0.75)

Kc =crop coefficient [at establishment (0.4), vegetative (0.8), flowering (1.2), seed setting (1.4), seed filling (0.8) and maturity (0.4) stages] (Chamundeswari *et al.*, 1997)

Sr =spacing between rows

Sp =sacing between plants. 30 cm (Sr) and 45 cm (Sp) was taken for all the spacings (30 cm x 30 cm, 30 cm x 45cm and 30cm x 60 cm) on an average basis.

IE =irrigation efficiency (90%) (Reddi and Reddy 1995

N = number of plants / emitter (4 plant/ emitter for all 3 spacings on an average basis)

Pw =wetting percentage (Jack Keller and Bliesner, 1990)

In control plots, water was given through open end pipes and these pipes were operated to meet the irrigation water requirement at an interval of 7 days . The crop was raised adopting the recommended cultural practices.

RESULTS AND DISCUSSION

Yield and yield components

Interaction effect between irrigation regimes and population densities on yield and yield components was non-significant. Significant increase in dry matter, yield components and seed yield was observed with drip irrigation scheduled at 1.0,0.8 and 0.6 of Etm as compared to ridge and furrow method of irrigation (control) scheduled at 1.0 of Etm, resulting in 49, 48 and 44% increase in yield in former three treatments over ridge and furrow irrigation,. Oil yield was also significantly higher in drip irrigation regimes than that of ridge and furrow irrigation due to more seed yield in drip irrigation.

Significant increase in seed yield under drip irrigation may be due to maintenance of field capacity in the crop root zone and lowering metric tension under drip irrigation. By this, the plant faced no stress conditions at any stage, which in turn enhanced the source capacity and sink strength to increase the yield components under drip irrigation, Thimmegouda *et. al* (1990) also reported higher yield under drip irrigation.

Water use efficiency

Irrigation regime through drip at 0.6 of Etm irrigation regime recorded significantly higher WUE than 0.8 and 1.0 of Etm. Drip irrigation regimes (0.8 and 0.6 of Etm) saved 17 and 33% water respectively over control. This saving of

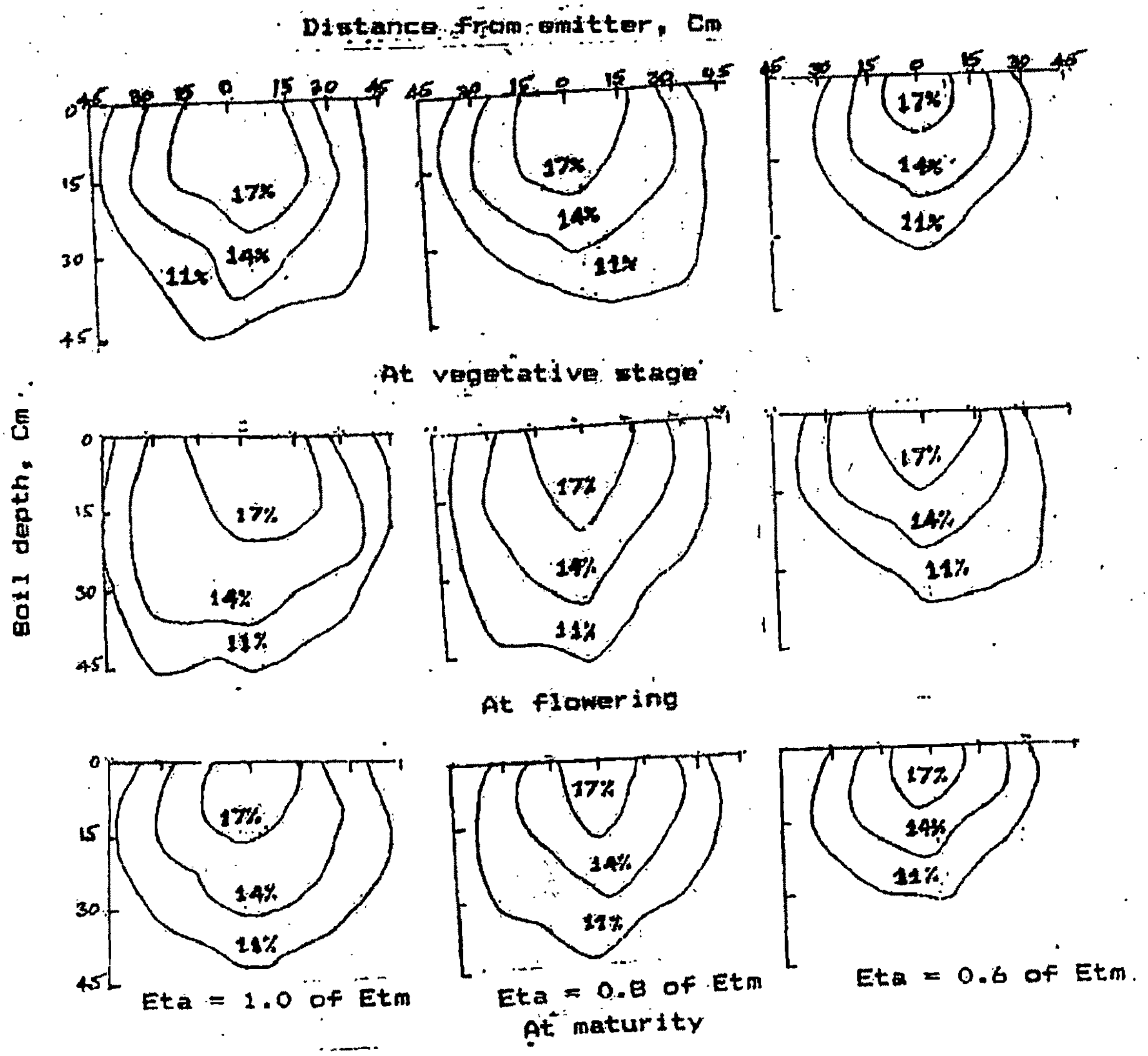

Fig. 1 : Soil moisture distribution pattern at different crop growth stages under drip irrigation

Table : Effect of irrigation regimes and population densities on growth, yield and seed yield attributes and water use efficiency of sunflower.

Treatment	Dry matter at harvest (g/plant) at 90 DAS	Head diameter (cm)	Filled seeds/ head	100 seed wt (g)	Seed yield (kg /ha)	Oil (%)	Oil yield (kgha^{-1})	Water applied (mm)	MUE ..... $^{-1}$)
Main treatment									
Irrigation regimes									
=1.0 of ETm :	72.20	17.50	588	44.30	2441	1053	43.10	433	5.60
=0.8 of ETm : Dt	69.70	17.00	580	45.40	2422	1053	43.40	363	6.60
=0.6 of ETm :	72.40	17.30	656	44.50	2354	1027	43.60	293	8.00
Control (ETa=1.0 ETm)	56.70	15.00	444	42.50	1639	705	43.00	436	3.70
SEm ±	3.70	0.60	59	0.70	73	35	0.80		0.20
CD (P=0.05)	9.10	1.50	143	1.70	253	122	NS		0.60
Sub-treatments									
Population densities									
30CmX30cm	64.60	16.32	471	44.10	2304	1000	43.40		6.20
30CmX45cm	69.00	16.72	618	44.30	2182	942	43.10		5.90
30CmX60cm	70.00	17.20	612	44.20	2158	935	43.30		5.80
SEm ±	2.10	0.30	56	0.64	28	17	0.64		0.08
CD (P=0.05)	4.44	0.63	120	NS	84	NS	NS		0.23

ETa = Actual evapotranspiration; ETm = Maximum evapotranspiration; R & F = Ridge and furrow method; DI = Drip irrigation; NS = Non significant

water was due to minimizing conveyance losses as deep percolation, runoff and soil evaporation and applying water effectively and directly at the root zone of plants in small amounts close to consumptive use of plants.

Close spacing of 30 cm x 30 cm 111000 plants ha^{-1} resulted in significant reduction in growth and yield components than that under wider spacings due to higher competition among plants. These results are in conformity with Bindra and Kharwara (1994). Wider spacing resulted in significantly higher dry matter and yield components due to more soil area available for supply of adequate amount of moisture, nutrients and less competition for light and aeration. However, closer spacing (30 cm x 30 cm) recorded more seed (2304 kg ha^{-1}) and oil yield (1000 kg ha^{-1}) in spite of having less number of filled seeds/ head and smaller head diameter. It was because of more number of plants per unit area compensating more than the reduction in yield components.

Moisture distribution pattern

At vegetative, flowering and maturity stages, the moisture distribution pattern under different drip (1.0, 0.8 and 0.6 of Etm) irrigation and ridge and furrow irrigation of 1.0 of Etm differed considerably (Fig 1).

At vegetative stage, in drip irrigation of Eta = 1.0 of Etm, 17% moisture (field capacity) was distributed upto 20-25 cm below and 15 cm right and left of the dripper. On the other hand, under 0.8 of Etm, 17% moisture was distributed upto 20 cm below emitter, 15 cm right and left of the driper and in 0.6 of Etm, 17% moisture was distributed upto 10-12 cm below emitter and 10 cm right and left to the dripper. The moisture distribution pattern at 14 and 11% moisture followed similar trend as that was observed under different irrigation regimes scheduled through drip method. This may be due to three dimensional water movement, better application efficiency, less evaporation loss and prevention of downward flow of water in to deeper layers.

In ridge and furrow method of irrigation, water content increased with soil depth but decreased with time. Immediately one day after irrigation, 12,16 (near field capacity) and 13 per cent moisture was observed upto 0-15 cm, 15-30 cm and 30-45 cm soil depth, respectively. But at 7 days after irrigation, the moisture content was 5, 7 (permanent wilting point) and 11 per cent in 0-15cm, 15-30 cm and 30-45 cm soil depth respectively. The decrease in water content might be due to more percolation, evaporation and uneven distribution of water and longer irrigation intervals, there by, greater depletion of soil moisture. Similar findings of moisture distribution under drip and furrow methods of irrigation in potato and tomato crops were reported by Singh *et. al.* (1978). The moisture distribution pattern at flowering and maturity stages under different irrigations was almost similar.

Root distribution

Drip irrigation scheduled at 1.0, 0.8 and 0.6 of Etm and control (ridge and furrow) irrigation scheduled at 1.0 of Etm resulted variation in rooting characteristics(root depth, spread and distribution). The root depth varied between 15-20 cm and 20-25 cm in drip irrigation and 20-25 cm and 25-30 cm in ridge and furrow irrigation (control, at vegetative and flowering stages, respectively.

In drip irrigated plots, the root spread of left and right plants, located at 30 cm to lateral and central plants (where lateral was placed) varied considerably. The root spread of central plants was more or less uniform to right and left sides and varied between 15-20 cm and 15-22 cm during vegetative and flowering stages, respectively, while, left and right plants root spread was more towards the lateral where dripper was placed than the other side. It varied between 15-20 cm and 20-25 cm towards lateral and 5-10 cm and 10-15 cm towards other side at vegetative and flowering stages, respectively. In ridge and furrow irrigated plots, the root spread on both sides was similar and varied between 5-10 cm and 10-15 cm during flowering stage. At maturity, the rooting pattern was similar to that of flowering stage.

The root distribution of central, left and right plants of the crop received irrigation through drip at 1.0 of Etm was similar on all sides and there was mostly active primary roots, while, the roots of plants in the crop received irrigation through drip at 0.8 and 0.6 of Etm mostly were secondary and they were more towards dripper side in left and right plants and roots were distributed on all sides equally in central plants. In ridge and furrow method, where irrigation was scheduled at 1.0 of Etm, les number of active primary roots were distributed on all sides equally. Similar findings were reported in field crops by Carmi *et al.* (1991, 1992), Ben Asher *et al.* (1992) and Plaut *et al.*(1996).

It can be inferred that the drip irrigation scheduled at 0.6 of Etm and closer spacing (30 cm x 30 cm) result in significantly higher seed yield and by adopting this irrigation regime there will be a saving of 30% water.

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Contingent Crop Planning for Rainfed Situation in Alfisols of Southern Agro-Climatic Zone

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ABSTRACT

Field experiments were conducted during late *Kharif* of 2001 and 2002 in dry land farm of Regional Agricultural Research Station, Tirupati with an objective to find out suitable contingent crop for late *kharif* season . Three dates of sowing in main plot and seven crops in sub-plot, were tested in split plot design. Groundnut pod equivalent yield exhibited no significant difference among the three different dates of sowing during *kharif* 2001, (1st fortnight of September , 2nd fortnight of September and 1st fortnight of October). However, during the *kharif* 2002 significantly the highest groundnut pod equivalent yield was obtained at the end of August (1718 kg ha^{-1}) followed by 2nd fortnight of September (1412 kg ha^{-1}) and 1st fortnight of October(830 kg ha^{-1}). Among different crops tried, the highest groundnut pod equivalent yield was obtained with field bean as vegetable (1759 and 2838 kg ha^{-1} in 2001 and 2002 respectively) followed by castor (1194 kg ha^{-1}) during 2001 and pigeonpea (2226 kg ha^{-1}) and castor 1547 kg ha^{-1}) during 2002. Significantly the lowest groundnut pod equivalent yield was recorded with sunflower during 2001 and groundnut during 2002. Net returns and benefit cost (B : C) ratio were the highest with field bean among different dates of sowing during both the years of study. During both the years of study all the crops (black gram, green gram, castor and pigeonpea) have performed well compared to groundnut, except sunflower in three dates of sowing in 2001 and sorghum in third date of sowing in 2002.

Key words: Contignet crop, Alfisols, Agro-climatic Zone.

Management of natural resources is a critical issue in dryland agriculture. The Southern Agro-climatic Zone of Andhra Pradesh consists of mostly alfisols with low moisture retentive capacity and characterized by rainfall received during South-West and North-East monsoon seasons from the June to November followed by occasional cyclonic rains during December, giving scope for better utilization by late sown crops. Groundnut is an important oilseed crop cultivated during *kharif* under rainfed situation in Southern Agro-Climatic Zone of Andhra Pradesh. Normally groundnut is sown during 1st fortnight of July for higher yields. Delayed sowings of groundnut beyond July reduced the yield by about 70 per cent (Reddy *et al.*, 1984). Pigeonpea as a substitute to groundnut under late sowing conditions can be considered (Verma, 1985). There is need to identify and evaluate remunerative contingent crops for delayed onset of monsoon in alfisols.

MATERIAL AND METHODS

Field experiments were conducted during *kharif* 2001 and 2002 at Regional Agricultural Research station, Tirupati. The soil was sandy loam, low in organic carbon (0.41%) and available nitrogen (181 kg ha^{-1}) medium in available P_2O_5 (24.5 kg ha^{-1}) and K_2O (176 kg ha^{-1}) with pH of 7.1. During the crop period, a total rainfall of 628.5 mm was received in 30 rainy days during 2001 and 466.2 mm in 33 rainy days during 2002. The experiment was laid out in split plot design with three dates of sowing as main plots and seven crops in sub-plots replicated thrice. The contingent crops for late *kharif* 2001, were black gram, green gram , castor, pigeonpea, sunflower, field bean, sorghum and groundnut was check, while during late *kahrif* 2002, sunflower was replaced by sorghum, blackgram (LBG-17), greengram (LGG-460) and groundnut (JL-24) were spaced at 30 x 10 cm, castor (Haritha), pigeonpea (Palanadu) were spaced at 60 x 20 cm, sunflower (Morden), field bean (Local) and sorghum (JKSH-1) were spaced at 45 x 15 cm, Net returns and benefit:cost (B :C) ratio were worked out based on the prevailing input cost. During 2001, of sowing dates were 7.9.01,15.9.01, 10.10.01 depcited as D_1, D_2 and D_3 respectively, while in 2002, sowing dates were 28.8.02. 17.9.02 and 16/10/02 as D_1, D_2 and D_3 respectively.

RESULTS AND DISCUSSION

Dates of Sowing

During both the years, the economic yield of different crops decreased as the sowing was delayed. Non-significant differences were obtained in groundnut pod equivalent yield (Table 1) among the three dates of sowing during 2001, which might be due to less time gap in dates of sowing. Sowing of contingent crops should not have been done in 2nd fortnight of August as there was no rainfall. However, in 2002 the highest groundnut pod equivalent yield of 1718 kg ha^{-1} was recorded when the crop was sown during 2nd fortnight of August (D_1) compared to later two dates of sowing (1412 and 830 kg ha^{-1}, respectively). The reduction in yield in different dates of sowing in 2002 was due to delay in sowing of contingent crops.

Contingent crops

Irrespective of dates of sowing, the highest economic yield was recorded with field bean as vegetable followed by castor and pigeonpea during both years under study (Table1). Among different crops tried, the highest groundnut pod equivalent was obtained with field bean as vegetable (1759 and 2838 kg ha^{-1} during 2001 and 2002, respectively) followed by castor (1194 kg ha^{-1}) during 2001 and pigeonpea (2226 kg ha^{-1}) and castor (1547 kg ha^{-1}) during 2002. Delayed onset of monsoons beyond 15 September made pigeonpea suitable for Sourthern Agro-climatic Zone of Andhra Pradesh (Ravindranath Reddy *et.al.*, 1997). Significantly the lowest groundnut pod equivalent was recorded with sunflower during 2001 and groundnut pod yield during 2002.

Table 1: Groundnut pod equivalent yield (kg ha^{-1}) of contingent crops under late kharif of 2001-02&2002-03

Treatment	Groundnut pod equivalent yield (kg ha^{-1})	
	Late kharif, 2002-03	Late kharif, 2001-02
MAINPLOTS		
Date of Sowing (D)		
M_1	925.00	1718.00
M_2	897.00	1421.00
M_3	921.00	830.00
SEm±	29.92	35.06
CD(P=0.05)	NS	138.00
SUB-PLOTS		
Contingent Crops* S_1	803.00 (Black gram)	890.00 (Black gram)
S_2	610.00 (Greengram)	825.00 (Greengram)
S_3	1194.00 (Castor)	1547.00 (Castor)
S_4	941.00 (Pigeonpea)	2226.00 (Pigeonpea)
S_5	459.00 (Sunflower)	669.00 (Sunflower)
S_6	632.00 (Groundnut)	266.00 (Groundnut)
S_7	1759.00 (Fieldbean)	2838.00 (Fieldbean)
SEm±	47.02	47.78
CD(P=0.05)	134.90	137.00

* Crops are mentioned in the parentheses

Table 2: Yield, net returns and B: C ratio of contingent crops during late *Kharif*, 2001 and 2002

Crop	D_1			D_2			D_3		
	Yield kg ha^{-1}	Net teturns Rs.ha^{1}	B :C	Yield kg ha^{-1}	Net teturns Rs.ha^{1}	B :C	Yield kg ha^{-1}	Net teturns Rs.ha^{1}	B :C
2001									
Blackgram	766	7256	2:45	682	5912	2:18	508	3218	1:63
Greengram	518	3288	1:65	483	2728	1:54	427	1832	1:37
Castor	2018	12180	2:52	1368	5680	1:71	1272	4720	1:59
Pigonpea	1544	7440	1:93	1175	3750	1:47	951	1510	1:19
Sunflower	473	Negative	-	587	Negative	-	316	Negative	-
Groundnut	830	790	1:08	679	Negative	-	390	Negative	-
Fieldbean	4182	18092	3:58	3805	15830	3:26	3445	13670	2:95
Sorghum	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002									
Blackgram	1041	10615	3:12	787	6825	2:36	909	8635	2:73
Greengram	906	8590	2:72	879	8185	2:64	680	5200	2:04
Castor	2963	19630	3:70	2562	17620	3:20	1437	6370	1:80
Pigonpea	3119	35247	5:07	2494	24422	4:05	1065	5845	1:73
Sunflower	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundnut	798	1970	1:12	Failed	-	-	Failed	-	-
Fieldbean	7670	38020	5:75	8146	40876	5:11	5495	24970	4:12
Sorghum	2794	10764	2:79	2222	7332	2:22	Failed	-	-

NA=Not applicable, Note : cost of cultivation and produce values were worked out with prevailing prices.

Economics

During 2001 and 2002, among the contingent crops tried under three dates of sowing for delayed monsoon conditions, field bean crop gave the highest net returns and B:C ratio (Table 2). In 2001, castor, balckgram, pigeonpea and greengram gave higher net returns and B:C ratio in three dates of sowing while sunflower crop gave lower yield and the net returns were negative. During 2002, pigeonpea and castor gave higher net returns and B:C ratio in the first two dates of sowing while in the third date of sowing blackgram and greengram gave higher net returns and B:C ratio. Sorghum performed well in the first two dates of sowing and failed in third date of sowing. During both the years of study groundnut performance was poor under delayed monsoon conditions compared to the other crops.

For Southern Agro-climatic situation, under delayed *kharif* till 2nd fortnight of September, field bean as vegetable, pigeonpea, castor, blackgram, greengram and sorghum are suitable contingent crops against groundnut. Castor, blackgram and greengram were found to be more suitable for sowing in the first fortnight of October under rainfed situation. Further, delay in sowing of contingent crops beyond 2nd fortnight of September resulted in reduced yields.

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Effect of Weed Management Practices on Growth and Yield of Dry Sown Rice

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ABSTRACT

A field experiment was carried out at the Agricultural College Farm, Bpatla to study the efficacy of herbicides and their integration with hand weeding on growth and yield of dry sown rice during *Kharif* 2004. Hand weeding twice i.e., at 20 and 40 DAS was found to be superior to the rest of treatments. Among all the treatments, pretilachlor @ 0.75 kg a.i. ha^{-1} (PRE) and pyrazosulfuron ethyl@ 20 g a.i.ha^{-1} (PRE) when supplemented with one hand weeding at 20 DAS was found superior to their supplementation with hand weeding at 40 DAS in reducing weed growth and recording higher crop growth parameters with high yield attributes next to hand weeding twice. Application of butachlor @ 1.5 a.i.ha^{-1} (PRE) 2,4-D Na salt @ 0.8 kg ai.i. ha^{-1}(POST) at 20 DAS was found superior to herbicides applied alone in recording good crop growth parameters and yield.

Key words : Weed Management, Dry Sown Rice, Growth and Yield

Rice is the food and commercial crop of farmers of Krishna-Godavari Zone in A.P. Due to low rain fall, water is not available early in the canals of Krishna delta in A.P. and hence, there has been very much delay in rice planting. In these conditions, rice can be sown dry using rain and later converted to wet paddy when water is available in canals. In dry sown rice, weed infestation during early stages of crop growth is severe and requires efficient methods of weed control in order to get better crop growth and ultimately higher yields. Conventional methods of weed control such as hand weeding may not be possible in such areas, where large labour force is needed at a time. Since the phenotypic appearance of grassy weeds, especially *Echinochloa colona* and *E.crusgalli* is closely related to rice seedlings, it is very difficult and not practicable to remove the weeds manually in the early stages of crop growth. Hence, pre-emergence application of selective herbicides is the only possible method of weed control during the early stages of crop growth. Hence, an experiment was conducted to study the effect of different herbicides on growth and yield of dry sown rice, at the Agricultural College Farm, Bapatla, during *Kharif,* 2004.

MATERIAL AND METHODS

The soil of the experimental field was caly with pH of 8.0 low in available nitrogen (230 kg ha^{-1}), medium in available phosphorus (11 kg ha^{-1}) and high in available potassium (937 kg ha^{-1}). Rainfall received during the crop growth was 314.2 mm in 19 rainy days. The trial consisted of 12 weed management treatments (treatmental details are furnished in Table) with the pre-emergence herbicides *viz.,* butachlor @ 1.5 kg a.i. ha^{-1} pretilachlor @ 0.75 kg a.i. ha^{-1} and pyrazosulfuron ethyl @ 20 g a.i. ha^{-1} applied alone (T_3, T_5 and T_6) each supplemented with hand weeding at 20 DAS (T_7,T_8 and T_9) and at 40 DAS (T_{10}, T_{11} and T_{12}) and one herbicide combination *i.e.,* butachlor @ 1.5 kg a.i.ha^{-1} (PRE) + 2,4-D Na salt @ 0.8 kg a.i. ha^{-1} (POST), weedy check (T_1) and hand weeding twice *i.e.,* at 20 and 40 DAS (T_2). The experiment was laid out in a randomized block design with three replications. Rice variety, Samba Mahsuri (BPT 5204) was sown adopting a seed rate of 50 kg ha^{-1}. The plot was fertilized with 100 kg N, 60 kg P_2O_5 and 40 kg K_2O) ha^{-1}. The pre-emergence herbicides were applied on the fourth day of sowing using foot operated sprayer. The data on plant growth characters, yield attributes and yield (grain and straw) were recorded and subjected to statistical analysis.

RESULTS AND DISCUSSION

The predominant weed species observed in the experimental field were *Cyperus rotundus, Fimbristylis milliacea* and *Cyperus difformis* in sedges; Cynodon dactylon, *Echinochloa crusgalli and Echinochloa colona* in grasses; and *Eclipta alba and Ammania baccifera* under broad leaved weeds.

All the weed management treatments were found to be significantly superior to weedy check in increasing the crop growth parameters and crop yield. Among the herbicide applied treatments, herbicides *viz.,* butachlor @ 1.5 kg a.i. ha^{-1} pretilachlor @ 0.75 kg a.i. ha^{-1} and pyrazosulfuron ethyl @ 20 g a.i. ha^{-1} supplemented with and weeding at 20 DAS (T_7,T_8 and T_9) was found superior to their supplementation with hand weeding at 40 DAS (T_{10}, T_{11} and T_{12}) herbicide combination of butachlor @ 1.5 kg a.i.ha^{-1} (PRE)

Table : Effect of weed managemetn treatments on growth, yield attributing characters and yield in dry sown rice

Treatments	Plant height at harvest (cm)	Tiller no m^{-2} at arvest	Total drymater acumulation ($kg\ ha^{-1}$) at maturity	Productive tillers m^{-2}	Grains per panicle	Test weight (g/1000 seeds)	Grain yield ($kg\ ha^{-1}$)	Straw yield ($kg\ ha^{-1}$)	Harvest index (%)
T_1	65.5	348.0	4441	266.6	87.5	14.0	1851	2611	41.1
T_2	78.2	682.7	11736	485.4	141.4	16.0	5444	5759	48.6
T_3	67.6	381.7	6870	282.6	94.1	14.0	3203	3999	44.4
T_4	70.5	432.3	7334	325.3	100.5	14.0	4129	4777	45.6
T_5	68.6	431.3	7286	312.0	97.5	14.6	3888	4555	45.5
T_6	67.9	393.3	7082	296.0	95.4	14.6	3574	4425	44.6
T_7	74.5	470.0	8577	365.3	121.1	15.3	4777	5222	47.8
T_8	75.4	528.0	10997	426.6	138.2	15.3	5185	5499	48.5
T_9	75.0	496.0	9496	402.6	127.6	15.3	4999	5407	48.0
T_{10}	71.5	440.0	7839	333.3	104.0	15.3	4111	4907	45.6
T_{11}	72.5	459.0	8258	354.6	113.7	15.3	4536	5199	46.7
T_{12}	71.9	457.0	8126	344.0	11.5	15.3	4296	5074	45.8
SEm±	1.4	8.8	74.1	10.3	0.9	0.7	123	95	0.7
CD	4.1	26.0	217	30.3	2.6	NS	362	278	1.9

PRE-Pre-emergence application, POST=Post-emergence application, NS=Non-significant, DAS=Days after sowing

+ 2,4-D Na salt @ 0.8 kg a.i. ha^{-1} (POST) at 20 DAS (T_4) and herbicides applied alone (T_3, T_5 and T_6) in recording higher crop growth parameters, yield attributes and yield. This was due to better control of weeds at early stages of crop growth which coincided with critical period of crop-weed competition.

Among all the treatments, hand weeding twice recorded higher crop growth parameters, yield attributing characters, grain yield (5444 kg ha^{-1}) and straw yield (5759 kg ha^{-1}) over rest of the treatments. Similar results of increased yields with and weeding were also reported by Moody and Mukhopadhyay (1982). Next to hand weeding twice, among the herbicide applied treatments, pretilachlor @ 0.75 kg a.i.ha^{-1} + hand weeding at 20 DAS recorded higher plant height (75.4 cm), total number of tillers (528 m^{-2}), dry matter accumulation (10997 kg ha^{-1}), productive tillers (426.6 m^{-2}), grains per panicle (138.2), grain yield (5185 kg ha^{-1}) straw yield (5499 kg ha^{-1}) and harvest index (48.5%) over rest of treatments. The higher grain yield and straw yield with pretilachlor supplemented with hand weeding @ 20 DAS was reported by Rajendran *et al.* (1999). It was found on a par with pyrazosulfuron ethyl plus hand weeding at 20 DAS in recording higher crop growth parameters. Higher growth parameters with pyrazosulfuron ethyl were reported by Moorthy (2002) in rainfed direct seeded lowland rice.

Application of butachlor (PRE) + 2,4-D sodium salt @ 0.8 kg a.i.ha^{-1} (POST) at 20 DAS recorded higher crop growth parameters, yield components and yield (grain and straw) than butachlor @ 1.5 kg a.i. ha^{-1} applied alone . The results are in agreement with the findings of Tripathi *et al.* (1998) and Singh and Namdeo (2004). Among the herbicides applied alone, butachlor recorded lower crop growth parameters and yield attributes than pretilachlor and pyrazosulfuron ethyl.

The study revealed that supplementation of hand weeding at 20 DAS to pre-emergence herbicides *viz.*, pretilachlor, pyrazosulfuron ethyl and butachlor recorded higher crop growth parameters and yield compared to supplementation of hand weeding at 40 DAS to these herbicides. Herbicide combination of butachlor @ 1.5 kg a.i. ha^{-1} (PRE) + 2,4-D Na salt @ 0.8 kg a.i.ha^{-1} (POST) at 20 DAS found superior to herbicides applied alone in recording good crop growth parameters and yield in dry sown rice.

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Journal
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Acreage Estimation Studies in Chilli Using Remote Sensing

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ABSTRACT

Chilli crop acreage estimation in Hubli taluk of Dharwar district, Karnataka was carried out for *kharif* 2002-03 by selection 26 ground truth sites using IRS ID LISS III imagery of 14th November 2002. The acreage estimation was done by running the supervised maximum likelihood classification. The acreage, thus estimated was compared with the Department of Horticulture estimates. The acreage under chilli crop in Hubli taluk was 14,224 ha and it showed a relative deviation of 7.27%.

Key words : Acreage Estimation, Chilli, Remote Sensing

Chilli (*Capsicum annuum* L.) is one of the most valuable commercial spice crops grown through out the country in diverse climatic conditions. In Karnataka, the crop is being extensively grown in Dharwad, Haveri, Gadag, Belgaum, Shimoga, Bellary and Chitradurga districts, occupying an area of 1,72,918 ha with a production of 1,51,043 t. Among all the districts, Dharwad alone occupies an area of 64,299 ha with a production of 54,23 t mainly covering Hubli, Kundagol and Dharwad taluks. In these districts, chilli is mostly grown as rainfed crop.

Remote sensing is the science and art of obtaining information about an object, area or phenomenon through the analysis of the data acquired by a device that is not in contact with the object, area or phenomenon under investigation (Lilles and Keifer, 2000). Remote sensing and its applications in agriculture are gaining importance because of its capability in providing regular, synoptic and fine resolution multi-spectral data from various satellites orbiting the earth's surface. Among all the applications, crop acreage and production estimation is of utmost importance to the country, in view of its advantages over the conventional procedures in providing the estimates of acreage and production of crops within less time, less cost and covering large areas.

Accurate and timely information on acreage of crops and yield of individual crops plays a critical role in our efforts for food security, distribution of agricultural outputs system and for taking decisions on export-import strategies. Conventional methods to generate such information employ large scale sample surveys for estimation of acreage and yield of crops through sample crop cutting experiments. They depend heavily on enumeration of data from village officials and often subjective.

The applications of remote sensing technology in acreage and production estimation of many crops like rice (Deka and Deb, 2000), wheat (Dhaliwal *et. al.*, 1994), sorghum (Potdar *et. al.*, 1991), soybean (Venkataratnam *et. al.*, 1994), chilli (Krishna Rao *et. al.*, 1997), groundnut, mustard and commercial crops like cotton are thoroughly studied and the procedures are well established. In case of crops like chilli, the studies are meagre. So, the present investigation was carried out to estimate the acreage of chilli crop in Hubli taluk of Dharwad district, Karnataka.

MATERIAL AND METHODS

Study area

The study area comprising Hubli taluk Dharwad district, Karnataka lies between 15° to 15° 30' E longitude. The total geographical area of Hubli taluk is 73,70 ha. The average rainfall of the region ranges from 626 to 727 mm per annum, which is mainly received during south west monsoon period from june to october and july is the peak rainfall month. The main crops of the study area in *kharif* season are chilli, cotton, redgram, groundnut and onion. Chilli crop is mainly raised under rainfed conditions as a pure crop or a mixed crop along with cotton. Chilli + cotton and chilli + cotton + onion mixed cropping are prevalent in Hubli taluk. The map of the study area is shown in Fig.1.

Ground truth data

A total of 26 ground truth sites for the collection of the observational data required for the current investigation were selected after conducting a preliminary survey of the study area and verification of the statistical data on the acreage under chilli crop.

The GARMIN 12 GPS receiver in stand alone mode was used to collect the information regarding the geographical location of the ground truth sites, which is used for marking of training sites. The spectral reflectance of the chilli, chilli + cotton was measured with the help of hand held multi band ground truth spectroradiometer in the spectral ranges equivalent to IRS LISS III sensor.

Satellite data

IRS ID LISS III digital data of Hubli taluk corresponding to path 97 and row 62 acquired on 14th November 2002, which coincides with the maximum vegetative growth to fruit ripening stage of chilli crop was selected for the present investigation.

Image analysis

Digital analysis of satellite data was carried out for deriving information on spatial extent of chilli crop grown in the study area. The IBM RS workstation with ERDAS IMAGINE 8.5 software at National Remote Sensing Agency, Hyderabad was used for the analysis and interpretation of remote sensing data. Geometric correction of the image was done using SOI toposheet of 1:50,000 scale.

The training windows were defined for various crops and other land use classes based on the ground truth information. Multiple training sites for each class were identified in order to represent the variability with in the same class. The image was classified using maximum likelihood algorithm and the taluk wise crop acreages were estimated.

The acreage statistics derived from remote sensing data were compared with that of Department of Horticulture (DOH) by calculating relative deviation (RD) given by

$$\text{RD (\%)} = \frac{\text{Remote sensing acreage} - \text{DOH acreage}}{\text{Remote sensing acreage}} \times 100$$

RESULTS AND DISCUSSION

Acreage estimation of chilli crop in Hubli taluk was done using IRS ID LISS III data with the help of ERDAS IMAGINE 8.5 software. The classification was run using supervised approach with MXL algorithum. The False Colour Comosite (FCC) and classified images of Hubli taluk were shown in Figures 2 and 3. The green colour in the classified image indicates the chilli growing

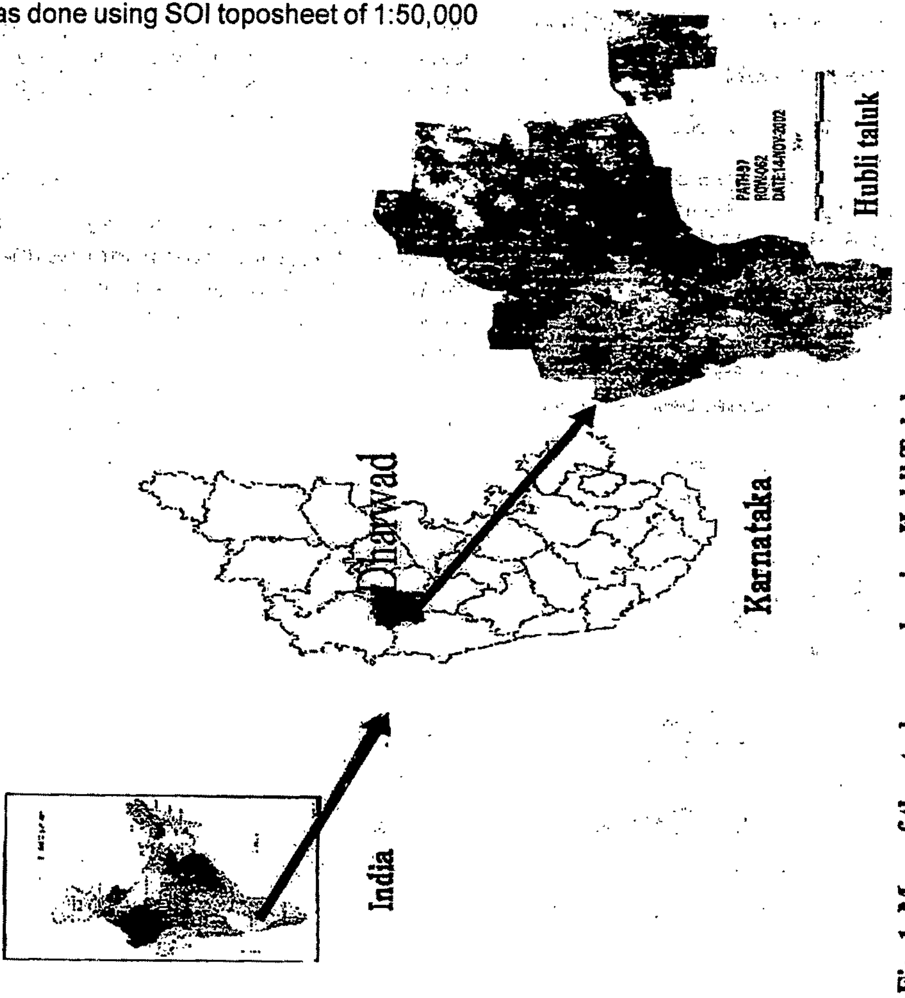

Fig. 1. Map of the study area showing Hubli Taluk

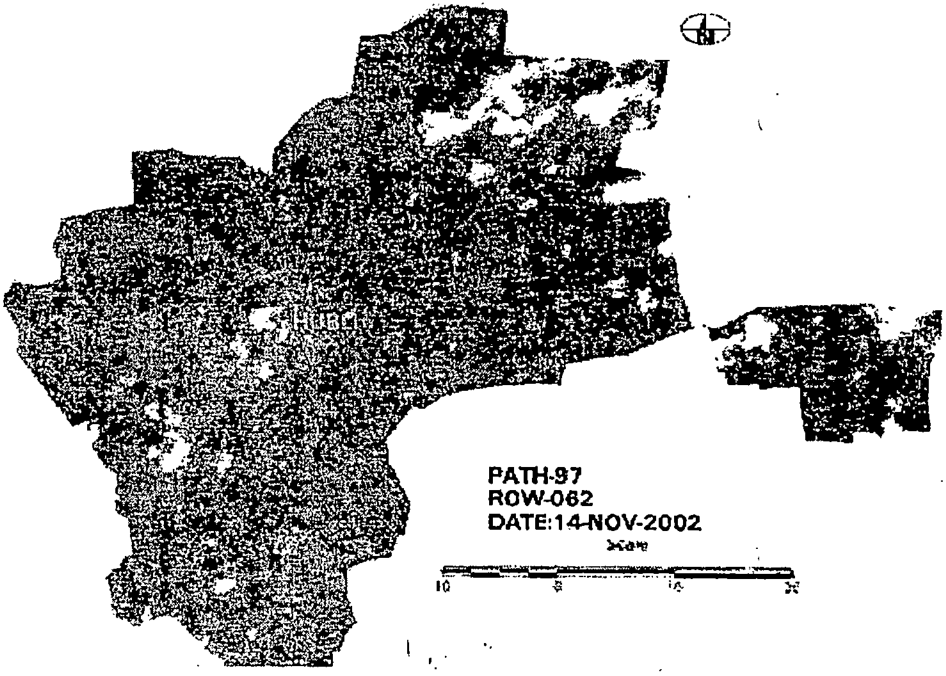

Fig.2. IRS ID LISS III enhanced False Colour Composite of Hubli taluk

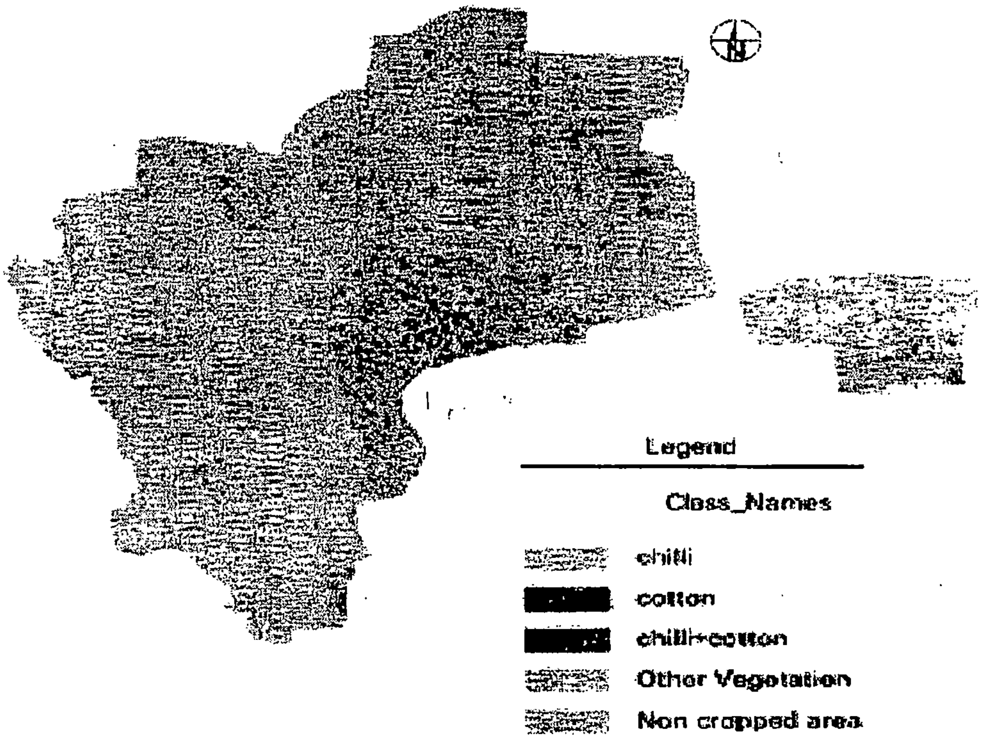

Fig.3. IRS ID LISS III classified image showing chilli crop in Hubli taluk

areas where chilli is grown as pure crop, brown colour indicates chilli as a mixed crop along with cotton and pink colour indicates cotton crop. The yellow colour indicates the area under other crops. The non-cropped area represented by gray colour includes the built-up areas like cities, towns, villages, roads, railway lines, water bodies, fallow lands and the areas covered by cloud and shadow. The results of the classification are presented in Table 1. The acreage under pure chilli crop was found to be 11,031.8 ha and the chilli + cotton mixed cropping system accounted for 3075.6 ha.

The estimated acreage under chilli crop was compared with the reported acreage of Department of Horticulture. The results of the comparison of acreage estimation are presented in Table 2. The estimated acreage was found to be deviating by –7.24 per cent. The reason for variation in estimates may be due to the clouds and cloud shadow covering some of the chilli growing areas. It was observed that some of the areas of Hubli taluk towards Hebsur, Nalavadi, Umachigi, Kiresur, Kusugal, Hubli city and the chilli fields near by Hubli city were covered by clouds and cloud shadow. The deviation may also be due to the crop failure at later stages of crop growth in some areas of the taluk which was aptly recorded in the satellite imagery and as the DOH estimates of acreage pertains to the chilli crop at sowing or transplanting time they include the actual sown transplanted area. This shows the advantages of remote sensing technique in providing accurate picture of the crop area which actually contributes to the production.

The information provided by using remote sensing techniques would decrease human errors due to the unbiased nature of the remote sensing data. The overall social benefits from reducing the error in estimates would result from improvement in decisions regarding inventory management, price fixation, import and export decisions based on improved estimates even before the crop is harvested. Thus, application of remote sensing techniques to crop identification and acreage estimation can result in greater economic benefits.

Table 1: Acreage under chilli crop and other classes in the study area.

Class Name	Acreage (ha) Hubli
Chilli	11031.76
Chilli + cotton	3075.63
Cotton	116.19
Fallow Land	14074.56
Built-up area	31415.70
Cloud	1963.70
Cloud Shadow	328.85

Table 2: Comparison of taluk level remote sensing and Department of Horticulture chilli acreage estimates for the year 2002-03

Study area	RS Acreage (ha)	DOH Acreage (ha)	Relative deviation (%)
Hubli	14224	15255	-7.24

RS = Remote sensing
DOH = Department of Horticulture

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Weed Management for Efficient Use of Nitrogen in *rabi* Maize (*Zea mays* L.)

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ABSTRACT

A field investigation was carried out at the Agricultural College Farm, Bapatla to study the effect of nitrogen and weed control measures in *rabi* maize (*Zea mays* L.). Density and drymatter of weeds increased significantly with successive increase in the levels of nitrogen from 50 to 150 kg N ha^{-1}. Weed free check, two hand weedings and alachlor @ 1.5 kg a.i. ha^{-1} + HW significantly reduced the weed population, dry matter and nitrogen uptake by weeds over weedy check and alachlor @ 1.5 kg a.i. ha^{-1} alone. Hand weeding twice at 3 and 6 weeks after sowing showed significant effect in reducing weeds and increased yield at 100 kg N ha^{-1} which was on a par with alachlor @ 1.5 kg a.i. ha^{-1} + hand weeding at 6 WAS when compared to weedy check at 150 kg N ha^{-1}.

Key words : *Rabi* Maize, Weed Management, Efficient Use of Nitrogen.

In Andhra Pradesh maize ranks next to rice and sorghum in importance as a food grain crop, cultivated in an area of 4.52 lakh hectares with a production of 14.72 lakh tones. Maize being an exhaustive crop, responds well to higher levels of nitrogen. On the other hand, heavy weed infestation is one of the major constraints that limit the productivity of maize crop. The growth of maize crop in the first 3-4 weeks is slow and during this period weeds establish rapidly and become competitive. Wider spacing in maize also provides enough opportunity for the weeds to invade and offer severe competition resulting in 30-100 per cent yield reduction (Rout and Satapathy, 1996). In order to increase fertilizer use efficiency by the crop, it is imperative to minimize weed competition particularly during the critical periods of crop weed competition.

MATERIAL AND METHODS

The field experiment was conducted during the winter season of 2001-02 at the Agricultural College Farm, Bapatla. The soil was alkaline in reaction with pH 8.1, clay loam in texture, low in available N (220 kg ha^{-1}), P_2O_5 (15 kg ha^{-1}) and high in available K_2O (647 kg ha^{-1}). Three nitrogen levels (50, 100 and 150 kg ha^{-1}) and 5 weed control measures (Weedy check, weed free check, 2 hand weedings at 3 and 6 WAS, alachlor @ 1.5 kg a.i. ha^{-1} as pre-emergence and alachlor @ 1.5 kg a.i. ha^{-1} + HW at 6 WAS) were tested in randomized block design with factorial concept replicated thrice. Maize was planted at an inter- and intra- row spacing of 60 cm x 30 cm during the first week of December and harvested during 2nd week of March. Entire dose of 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1} along with 50 per cent of nitrogen was applied at the time of sowing. The remaining half of N was topdressed at 45 DAS. Weed population and weed drymatter were recorded at 20, 40, 60 DAS and at harvest by placing a quadrat of 50 x 50 cm randomly in two places at each plot. The weed data were subjected to log transformation to reduce large variations.

RESULTS AND DISCUSSION

Weed density and drymatter increased significantly with increasing levels of nitrogen from 50 to 150 kg N ha^{-1} at all growth stages except maturity, where 150 kg N ha^{-1} was on a par with 100 kg N ha^{-1}. increasing quantities of nitrogen might have increased weed density and promoted the vigour of the plant, reflecting in increased weed drymatter. Similar results were reported by Angrias and Singh (1988). Among weed control measures, hand weeding twice was most effective as it eliminated all early-emerged weeds at 21 DAS, while, the second weeding at 42 DAS removed the weeds germinated later keeping the weed density and drymatter of weeds below the critical level of competition.

Herbicide application treatments (alachlor alone and alachlor + hand weeding at 42 DAS) were found superior and recorded better weed suppression during early stages of crop growth (20 DAS). This indicated the bio-efficacy of herbicide in controlling the weeds at the early stages, as alachlor is a selective pre-emergence herbicide, which is effective against annual grasses, sedges and some broad-leaved weeds. Further, integration of herbicide with hand weeding was more effective in reducing weed drymatter

Table1 : Weed density, drymatter, nitrogen uptake by weeds and grain yield of maize as influenced by nitrogen levels and weed control

Nitrogen Levels	Weed density (No. m^{-2}) Days after sowing				Weed drymatter (g. m^{-2}) Days after sowing				Nitrogen uptake by weeds (kg ha^{-1}) Days after sowing				WCE (%) at maturity	Weed index (%)	Grain yield (kg ha^{-1})
	20	40	60	Maturity	20	40	60	Maturity	20	40	60	Maturity			
N_1 - 50 kg ha^{-1}	2.61 (23.94)	2.98 (39.26)	3.20 (51.99)	3.18 (47.42)	1.43 (7.4)	1.95 (12.33)	1.85 (14.0)	2.19 (17.96)	1.37 (4.94)	1.56 (6.71)	1.76 (10.81)	1.98 (11.31)	--	--	2194
N_2 - 100 kg ha^{-1}	2.78 (28.77)	3.16 (47.60)	3.30 (59.86)	3.28 (54.07)	1.72 (8.8)	2.09 (14.40)	2.05 (16.0)	2.41 (21.44)	1.72 (7.27)	1.79 (9.17)	2.18 (15.27)	2.18 (14.98)	--	--	2939
N_3 - 150 kg ha^{-1}	2.94 (35.84)	3.22 (51.20)	3.43 (67.06)	3.36 (59.36)	1.84 (9.6)	2.22 (16.82)	2.27 (19.0)	2.56 (24.66)	1.98 (9.72)	2.02 (12.56)	2.37 (18.90)	2.37 (17.88)	--	--	4025
SEm+	0.02	0.02	0.01	0.03	0.03	0.01	0.03	0.01	0.04	0.03	0.07	0.03	--	--	69
CD (P=0.05)	0.07	0.06	0.05	0.11	0.11	0.05	0.09	0.04	0.12	0.09	0.21	0.09	--	--	200
Weed control measures															
W_1 - Weedy check	3.99 (55.72)	4.58 (98.77)	4.97 (143.22)	4.73 (115.91)	2.84 (17.0)	3.71 (41.67)	3.88 (49.0)	3.95 (52.70)	2.34 (11.00)	3.14 (24.77)	3.58 (37.50)	3.37 (30.43)	--	50.4	2072
W_2 - Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0	4180
W_3 - Two hand weedings	3.91 (50.81)	3.10 (22.77)	3.62 (38.33)	3.71 (41.85)	2.85 (17.0)	1.68 (5.50)	1.58 (5.2)	2.17 (9.16)	2.33 (10.84)	1.46 (4.51)	1.98 (8.49)	2.23 (9.48)	82.6	23.0	3218
W_4 - Alachlor @ 1.5 kg ai ha^{-1}	2.97 (19.98)	4.02 (57.11)	4.32 (76.44)	4.19 (67.13)	1.30 (3.9)	2.52 (12.62)	3.16 (24.0)	3.52 (34.48)	1.84 (7.01)	2.18 (9.09)	2.96 (20.41)	3.10 (23.75)	34.5	34.3	2743
W_5 - Alachlor @ 1.5 kg ai ha^{-1} + HW at 6 WAS	3.03 (21.07)	3.94 (51.44)	3.67 (40.33)	3.74 (43.21)	1.32 (3.9)	2.52 (12.81)	1.67 (5.6)	2.30 (10.40)	1.94 (7.70)	2.18 (9.04)	2.01 (8.58)	2.25 (9.98)	80.2	26.9	3052
SEm+	0.03	0.03	0.02	0.05	0.04	0.02	0.04	6.01	0.05	0.04	0.09	0.04			89
CD (P=0.05)	0.09	0.09	0.07	0.14	0.14	0.06	0.11	0.05	0.16	0.11	0.27	0.12			258
Interaction (NxW)	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.			Sig

The data are log transformed values, The figures in parentheses are original values. Sig= Significant, NS = Non-significant.

and it was on a par with hand weeding twice throughout the crop growth. The left over weeds which were not controlled by pre-emergence herbicide application were removed with hand weeding at 42 DAS, resulting in lower weed density and drymatter in the integrated method as also reported by Paradkar and Sharma (1993).

Interaction effect between nitrogen levels and weed control measures was significant on weed density and drymatter at all growth stages except weed density at maturity. Nitrogen availability in copious amounts both for weeds and crop might have resulted in increased weed density and weed drymatter with increasing levels of nitrogen in weedy check. However, the pre-emergence herbicide could effectively suppress the weed density and drymatter (W_1 and W_5) even at higher levels of nitrogen.

Treatments like hand weeding twice followed by herbicide + hand weeding at 42 DAS maintained higher weed control efficiency and lower weed index over other treatments. However, when alachlor was applied alone, the weed control efficiency decreased with time up to maturity as late emerged weeds and herbicide resistant weeds persisted, reducing the WCE as compared to alachlor @ 1.5 kg a.i. ha^{-1} + hand weeding at 6 WAS.

The maximum grain yield of 4025 kg ha^{-1} was recorded with the application of 150 kg N ha^{-1}. Weed free check followed by hand weeding twice and combination of alachlor @ 1.5 kg kg a.i. ha^{-1} recorded higher grain yield compared to herbicide alone and weed free check. Weed free check recorded significantly higher grain yield at 100 kg N ha^{-1} comapred to weedy check at 150 kg N ha^{-1}. Similarly, two hand weedings (W_3) and alachlor + hand weedings (W_5) recorded higher grain yield on a par with weedy check (W_1) at 150 kg N ha^{-1} in accordance with Pandy *et. al.* (1997).

Nitrogen uptake by weeds increased with increasing level of nitrogen at all the stages of crop growth. Maximum nitrogen uptake by weeds was recorded when 150 kg N ha^{-1} was applied.

In general nitrogen uptake by weeds was the highest in weedy check, while the lowest was with hand weeding twice throughout the crop period except at 20 DAS. However, the later was on a par with application of alachlor @ 1.5 kg a.i. ha^{-1} + hand weeding at 60 DAS and maturity. The lowest nitrogen uptake was noticed with two hand weedings (W_3) and alachlor @ 1.5 kg a.i. ha^{-1} + hand weedings (W_6) at all the levels of nitrogen.

Hand weeding twice at 3 and 6 WAS significantly reduced the weeds and nitrogen uptake by weeds and increased the maize yield at 100 kg N ha^{-1} which was on a par with alachlor @ 1.5 kg a.i. ha^{-1} + hand weeding at 6 WAS.

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Journal
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Productivity and Quality of Maize (*Zea mays* L) as Affected by Foliar Application of N and Zn at Flowering

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ABSTRACT

A field experiment was conducted at the Agricultural College Farm, Bapatla, on clay loam soils during *rabi* season of 2003-04. Chlorophyll content of ear leaf measured at 50% tasseling was significantly high with the application of 50 kg $ZnSO_4$ ha^{-1} to soil than that with any other treatments. At 50% silking, chlorophyll content was significantly improved with application of 2 per cent urea and 0.5 per cent $ZnSO_4$ spray at 50% tasseling. Dry matter production at all sampling dates was significantly higher with the application of 50 kg $ZnSO_4$ ha^{-1} to soil than that with any other treatment. Similarly, application of $ZnSO_4$ @ 50 kg ha^{-1} to soil along with N P K gave significantly higher yield and yield attributes except test weight. However, the quality parameters such as protein and Zn contents of grain and stover, and density of grain were improved significantly with the spray application of 2 per cent urea and 0.5 per cent $ZnSO_4$ at 50% silking than that of the rest of the treatments.

Key words : Maize, Quality, Foliar Application, Zinc, Urea

Maize is being grown in India primarily as a food grain crop to meet the food demand for humans and animals. Improvement in grain protein content and in certain micronutrients like Fe and Zn through agronomic practices may go a long way in securing nutritional health of humans and animlas.

MATERIAL AND METHODS

A field experiment was conducted at the Agricultural College Farm, Bapatla, Andhra Pradesh during *rabi* of 2003-04. The soil was clay loam in texture, slightly alkaline in reaction, low in available nitrogen (180 kg ha^{-1}), medium in available phosphorus (30 kg ha^{-1}), high in available potassium (637 kg ha^{-1}) and low in available zinc (0.58 ppm) with 0.38% of organic carbon content. The experiment comprised ten treatments *viz.*, T_1 : Control; T_2: 50 kg $ZnSO_4$ ha^{-1} as soil application; T_3 : 2 per cent urea spray at 50% tasseling; T_4 0.5 per cent $ZnSO_4$ spray at 50% tasseling; T_5 2 per cent urea and 0.5 per cent $ZnSO_4$ spray at 50% tasseling; T_6 2 per cent urea spray at 50% silking; T_7: 0.5 per cent $ZnSO_4$ spray at 50% silking; T_8 : 2 per cent urea and 0.5 per cent $ZnSO_4$ spray at 50% silking; T_9 : 2 per cent urea spray at 50% tasseling and 50% silking and T_{10} : 0.5 per cent $ZnSO_4$ spray at 50% tasseling and 50% silking which were replicated thrice in randomized block design. Recommended dose of 120 kg N (in three equal splits at sowing, knee high and tasseling stages), 40 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied. Zinc sulphate @ 50 kg ha^{-1} was applied to soil after N, P and K application. For foliar application of N and Zn, sprays of urea (2%) and $ZnSO_4$ (0.5%) were given (500 L ha^{-1}) with hand sprayer during morning hours between 7 a.m. and 10 a.m. However, no measurable foliar burning or precipitation was recorded within 24 hours of foliar treatments.

RESULTS AND DISCUSSION

Chlorophyll content of ear leaf and dry matter accumulation at different times during the crop growth (Table 1) were significantly affected by the treatments. The total chlorophyll content at 50% tasseling was significantly higher in the treatment that received 50 kg $ZnSO_4$ ha^{-1} as soil application (T_2) than the rest of the treatments. The significant improvement in the chlorophyll content with the application of Zn to soil over the recommended N P K might be due to the beneficial effect of Zn on various enzymatic reactions which inturn might have helped to improve chlorophyll content of ear leaf (Amarsingh *et. al.*, 2000).

At 50% silking, application of 2 per cent urea and 0.5 per cent $ZnSO_4$ spray at 50% tasseling (T_5) proved significant in increasing chlorophyll content. Whereas, at 15 days after silking, chlorophyll content recorded with application of 2 per cent urea and 0.5 per cent $ZnSO_4$ spray at 50% silking (T_8) or 2 per cent urea spray at 50% tasseling and 50% silking (T_9) showed no difference but were superior to other treatments.

The highest dry matter production was observed at 50 kg $ZnSO_4$ ha^{-1} to soil along with N P K (T_2). Application of Zn to soil might have helped to maintain higher auxin content, which inturn enabled the plant to growth taller and led to intercept more light. Further, maintenance of high chlorophyll content might have helped in

Table 1: Total chlorophyll content, dry mattter production and barrenness in maize at different growth states as affected by the application of nitrogen and zinc.

Treatments	Chlorophyll content of ear leaf (mg g^{-1} of fresh wt)			Dry matter at maturity (kg ha^{-1})	% barren plants	No. ofcobs $plant^{-1}$	Cob length (cm)	No. of grains rows cob^{-1}	No. of grains cob^{-1}	Grain weight (g cob^{-1})	100-grain weight (g)
	50% tasseling	50% silking	15 days after silking								
T_1 Control	1.40	0.87	0.72	8734	5.8 (2.6)	1.06	12.2	13.1	256	54.07	20.7
T_2 50 kg $ZnSO_4$ ha^{-1} as soil application	1.65	1.01	0.83	10503	4.0 (2.2)	1.20	13.6	13.5	271	56.77	21.0
T_3 2% urea spray at 50% tasseling	1.38	1.15	0.99	8891	1.2 (1.5)	1.13	12.4	13.1	257	55.69	21.4
T_4 0.5% $ZnSO_4$ spray at 50% tasseling	1.41	1.10	0.93	8802	1.6 (1.6)	1.07	12.3	13.0	256	55.17	21.4
T_5 2% urea and 0.5% $ZnSO_4$ spray at 50% tasseling	1.37	1.22	1.10	9267	1.2 (1.5)	1.06	12.8	13.2	259	56.73	21.8
T_6 2% ureas spray at 50% silking	1.39	0.92	1.23	9155	1.2 (1.5)	1.07	12.7	13.2	260	56.68	21.5
T_7 0.5% $ZnSO_4$ spray at 50% silking	1.36	0.90	1.03	8964	1.2 (1.5)	1.07	12.6	13.1	258	55.43	21.5
T_8 2% urea and 0.5% $ZnSO_4$ spray at 50% silking	1.36	0.88	1.25	9425	0.7 (1.3)	1.13	12.9	13.2	260	57.72	22.2
T_9 2% urea at 50% tasseling and 50% silking	1.40	1.16	1.24	9372	1.1 (1.4)	1.06	13.0	13.2	260	56.81	21.9
T_{10} 0.5% $ZnSO_4$ spray at 50% tasseling and 50% silking	1.39	1.08	1.07	9083	1.2 (1.5)	1.07	12.5	13.1	258	55.73	21.5
SEm+	0.03	0.02	0.02	305.2	0.10	0.10	0.10	0.10	3.30	0.30	0.09
CD (0.05)	0.10	0.05	0.07	906.4	0.30	NS	0.40	0.20	9.82	0.40	0.20

* All treatments received recommended NPK ** Figures in parentheses are $\sqrt{x+1}$ transformation values, NS = Non-significant.

better photosynthetic activity, which inturn might have resulted in higher dry matter production as also reported by Shukla *et. al.* (1978)

The percentage of barren plants was significantly decreased with foliar sprays of urea (T_3, T_6 and T_9), Zn (T_4, T_7 and T_{10}) or urea and Zn (T_8 and T_5) than with soil application of $ZnSO_4$ @ 50 kg ha^{-1} (T_2) or with the application of N P K recommended fertilizer only (T_1). The superior performance of these sprays could be attributed to increased translocation of current photosynthates to sink, which was supported by maintaining higher chlorophyll content at grain-filling stage as was evident from the chlorophyll content estimated at 15 days after silking.

All the yield attributes such as cob length, number of grain rows cob^{-1}, number of grains cob^{-1} except cob weight and 100-grain weight (Table 2) showed significant improvement by the addition of Zn to soil (T_2) than those showed by the rest of the treatments. Significant increase in test weight, however, was observed with the application of 2 per cent urea and 0.5 per cent $ZnSO_4$ spray at 50% silking (T_8) than with the rest of the treatments. Such superiority of urea and Zn spray at 50% silking was probably because of better absorption of N and Zn through foliage and their synergistic effect in maintaining higher chlorophyll content of ear leaf which might have supported for higher turn out of current photosynthates sparable for better grain-filling and hence higher 100-grain weigh as also reported by Singh and Jagdish (1978). Addition of $ZnSO_4$ to soil @ 50 kg ha^{-1} was significantly superior to other treatments in recording higher grain and stover yields. The improvement in dry matter accumulation and yield attributing characters with the addition of Zn to soil was reflected in the increase of grain and stover yields.

All the quality parameters (Table 2) such as grain density, protein and Zn content of grain and stover showed significant improvement with the application of 2 per cent urea and 0.5 per cent

Table 2: Grain yield, grain density, protein content and Zn contents of grain and stover as affected by the application of nitrogen and zinc.

	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Grain density (kg L^{-1})	Protein content %		Zn content ppm	
				Grain	Stover	Grain	Stover
T_1 Control	3738	4637	0.26	11.4	5.5	24	17
T_2 50 kg $ZnSO_4$ ha^{-1} as soil application	4663	5524	0.29	12.2	5.8	31	24
T_3 2% urea spray at 50% tasseling	3865	4723	0.34	13.4	6.7	25	18
T_4 0.5% $ZnSO_4$ spray at 50% tasseling	3812	4678	0.33	12.1	6.0	29	22
T_5 2% urea and 0.5% $ZnSO_4$ spray at 50% tasseling	4176	4913	0.40	13.7	6.9	29	22
T_6 2% ureas spray at 50% silking	4056	4884	0.36	13.7	6.8	26	19
T_7 0.5% $ZnSO_4$ spray at 50% silking	3945	4778	0.35	12.9	6.3	31	24
T_8 2% urea and 0.5% $ZnSO_4$ spray at 50% silking	4206	5070	0.45	14.5	7.4	32	25
T_9 2% urea at 50% tasseling and 50% silking	4163	4995	0.41	14.4	7.3	27	20
T_{10} 0.5% $ZnSO_4$ spray at 50% tasseling and 50% silking	3997	4818	0.36	12.7	6.4	34	27
SEm±	151.4	152.2	0.01	0.17	0.06	0.56	0.60
CD (0.05)	450.0	452.0	0.02	0.50	0.20	1.66	1.77

* All treatments received recommended NPK.

$ZnSO_4$ spray to foliage at 50% silking (T_8). This increase might be due to accelerated N metabolism with the supply of N through foliage and increased activity of nitrate reductase enzyme. Further, Zn, being activator of many enzymes, might have helped in activation of RNA polymerase, integration of ribosomes and reduction of RNA degradation, which, might have resulted in higher protein content. Mishra and Srivastava (1985) and Venkateswarlu and Misra (1987) also reported similar results.

This study indicated the improvement of physical and nutritional quality of grain through foliar application of urea and zinc sulphate at flowering.

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Physiological Parameters of Groundnut as Affected by Moisture Conservation and Fertilization

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ABSTRACT

Four *in-situ* moisture conservation treatments *viz.*, flat bed, ridge and furrow, broad bed and furrow and deep ploughed seed beds and three fertilization treatments *viz.*, control, 50% RF + FYM 5 t ha^{-1} and 100% RDF were tested on GG 20 groundnut during rainy season. Results showed that plant height, dry matter, accumulation chlorophyll a, chlorophyll b and total chlorophyll, pod and haulm yields were higher in ridges and furrow, broad bed and furrow and deep ploughed seed beds over flat bed. Application of 100% RDF registered significantly the highest plant height, dry matter accumulation chlorophyll a, total chlorophyll, crop growth rate, relative growth rate, net assimilation rate, pod yield and haulm yields. Leaf area index was un influenced by moisture conservation treatments whereas number of branches plant^{-1} were equally influenced by both moisture conservation and fertilization treatments.

Key words : Groundnut, Fertilization, *In-situ* Moisture Conservation, Physiological Growth Parameters.

In the semi-arid tropics, crop production is highly unstable under rainfed conditions because the crop production depends entirely on rainfall, which often is erratic with long dry spells, occurring during crop period. The coincidence of such dry spells with vital phenophases of the crop spell proved to be disastrous for crop production. The nature of the land relief in dry lands is such that they are sloppy and uneven which promote runoff, water going as a waste. Further, the soils in these dry farming areas are not only thirsty but hungry. Hence, fertilizer management is an other key factor for improving productivity in rainfed areas.

Recent thinking has been to devise methods of land treatment which will facilitate more efficient capturing of rainfall, minimize runoff water and increase its use by more efficient crops. The in-situ collection of runoff water does not involve major movement of soil and cost, the direction in which research efforts are more of use to the farming situation prevalent in Saurashtra region. Keeping these aspects in view, an experiment was conducted for two consecutive rainy seasons to study the influence of in-situ moisture conservation and fertilization treatments on some of the important physiological growth parameters and yield of groundnut variety GG-20.

MATERIAL AND METHODS

The field experiment was laid at the Instructional Farm of the College of Agriculture, Gujarat Agricultural University, Junagadh. The experiment consisted of four in-situ moisture conservation treatments *i.e.*, flat bed, ridges and furrow, broad bed and furrow and deep ploughed seed bed in main plot, three fertilization treatments *i.e.*, control, 50% RDF + 5 t FYM ha^{-1} and 100 RDF (recommended dose of fertilizer is 12.5 and 25 kg N and P_2O_5 ha^{-1}) in sub plot of split plot design replicated four times.

The experimental soil was clayey with 7.8 pH and 0.34 EC. Available nitrogen status of the soil was 264.0 kg ha^{-1}, available P_2O_5 was 31.50 kg ha^{-1} and available K_2O was 171.0 kg ha^{-1}. Field capacity and PWP were 27.2% and 12.6% respectively. Groundnut variety GG 20 was sown in rows spaced at 60 cms using 120 kg kernels ha^{-1}. Crop was grown by adapting recommended package of practices and observations on growth and yield were collected by standard procedures. To draw the conclusions, pooled data of the two years experimentation were used.

RESULTS AND DISCUSSION

Effect of *in-situ* moisture conservation

Effect of the treatments on growth parameters and yield of groundnut (Table) indicated the significant influence of the moisture conservation treatments on plant height, dry matter accumulation, total chlorophyll and relative growth rate. Number of branches plant^{-1}, leaf area index, crop growth rate and net assimilation rate were uniformly influenced by all the moisture conservation treatments.

Ridges and furrow, broad bed and furrow and deep ploughed seed bed treatments were statistically comparable and significantly superior over the flat bed treatment at 60 and 90 DAS with regard to plant height, dry matter accumulation and chlorophyll content. The least plant height (20.3 cm), dry matter accumulation (9.1 and 14.9 g) was observed in flat bed treatment at 60 and 90 DAS. The lowest chlorophyll 'a' (0.825 mg/g), chlorophyll 'b' (0.249 mg/g) and total chlorophyll (1.074 mg/g) were also recorded in flat bed treatment.

Table : Growth, physiological parameters and yield of GG.20 groundnut as infleucned by in-situ moisture conservation and fertilization treatments.

Treatment	Plant height 90 DAS	No.of branches 90 DAS	Drymatter accumulation 90 DAS	Total chlorophyll content (mg/g) at 60 DAS	Physiolgical growth parameters (60-90 DAS)			Yield (q/ha)	
					CGR	RGR	NAR	Pod	Haulm
In-situ moisture conservation									
Fat bed	23.3	5.8	14.9	1.074	3.001	0.015	0.743	19.0	28.7
Ridges and furrows	27.7	5.8	16.8	1.440	3.002	0.013	0.726	22.8	33.2
Broadbed and furrow	30.0	5.9	17.4	1.397	3.007	0.012	0.720	23.9	35.2
Deep planghed seed bed	28.2	5.9	17.1	1.423	3.032	0.012	0.720	23.8	35.2
SEm+	0.79	0.16	0.29	0.041	0.05	0.000	0.02	0.7	1.1
CD (P=0.05)	2.34	NS	0.88	0.121	NS	0.001	NS	2.2	3.3
Fertilization									
Control	24.2	5.9	14.7	1.205	2.836	0.014	0.749	19.5	30.4
50% RF + 5t FYM/ha	27.2	5.8	16.7	1.334	3.113	0.014	0.745	22.5	33.3
100% RDF	30.3	5.9	18.4	1.418	3.136	0.012	0.687	25.2	35.6
SEm+	0.58	0.10	0.29	0.023	0.05	0.000	0.62	0.6	0.8
CD (P=0.05)	1.66	NS	0.78	0.067	0.15	0.001	0.04	1.7	2.3

CGR = Crop growth rate, RGR = Relative growth rate, NAR = Net assimilation rate, NS= Non-significant.

This may be due to the favourable loose and supporting soil at the base and favourable aerated situation for absorption of water and nutrients in the altered land configuration for soil moisture conservation. The taller plants and high available moisture and nutrients could be the reason for higher dry matter accumulation and chlorophyll in these treatments. Similar results were also reported by Munuswamy *et. al.* (1998). Physiological growth parameters *viz.*, CGR and NAR were equally influenced by different moisture conservation treatments while there was not a specific trend of different treatments impact in respect of RGR (Table 2). This might be due to the fact that vegetative growth recouped after the release of stress due to the rains received and there could be a rapid raise in leaf recovery.

Pod and haulm yields were also significantly higher in ridges and furrow, broad bed and furrow and deep ploughed seedbed methods of moisture conservation. The flat bed treatment registered the lowest pod and haulm yields, 19.0 and 28.7 q ha^{-1}, respectively. The lower availability of soil water may increase the soil temperature in flat bed over other treatments where soil moisture was relatively more. Thus the higher temperature along with low available soil moisture may result in closure of stomata which tend to raise the plant temperature. This would lead to greater respiration and break down of the assimilates. Similar results were also reported by Bhoi *et. al.* (1993).

Effect of fertilizer treatments

Except the number of branches plant^{-1}, all other growth and yield parameters were significantly influenced by fertilizer management treatments. In most of the cases, the fertilization treatments differed significantly with one another. Applying 100% RDF followed by 50% RDF + 5 t FYM/ha recorded the tallest plants (22.9 cm and 30.3 cm), highest dry matter accumulation (12.3 g and 18.4 g), maximum leaf area index (4.20 m^2 and 5.05 m^2 land area) during 60 and 90 DAS. The highest chlorophyll (chlorophyll 'a': 1.116 mg/g, chlorophyll 'b' 6.302 mg/g and total chlorophyll : 1.418 mg/g) at 60 DAS was also registered in the treatment receiving 100% RDF the highest crop growth rate 1.418 was also recorded in the treatment with100% RDF and 50 RDF + 55 t FYM ha^{-1} both registered 3.136 RGR value during 60-90 DAS which was significantly superior to control treatment. But the control treatment recorded the maximum NAR 0.749 during 60-90 DAS.

P30822

The growth and development of plants depend upon differentiation and expansion of component cells. Nitrogen and phosphorus encourage the formation of new cells, cell division and cell multiplication. Further the added FYM increase the absorptive power of soil for cations and anions. These adsorbed ions are slowly released for the crop growth resulting in better nutrient availability. Thus these increased growth parameters could be due to the increased nutritional environment, as also reported by Devidayal (1997) and Kachat (1999).

Pod and haulm yields were significantly influenced by different treatments. With the increased fertilization, pod yield was increased. All the treatments differed significantly with each other. The highest (23.2 q ha^{-1} and 35.6 q ha^{-1}) and the lowest (19.5 q ha^{-1} and 30.4 q ha^{-1}) pod and haulm yields were registered in 100% RDF and control treatments, respectively. The higher availability of plant nutrients, higher growth parameters in the fertilized treatments might have resulted in the higher yields. The higher availability of plant nutrients, higher growth parameters in the fertilized treatments might have resulted in the higher yields as also reported by Parasuraman *et. al.* (1998).

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Performance of Fodder Maize – Coriander Sequence at Different FYM and Nitrogen Levels

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ABSTRACT

A field experiment was conducted to study the performance of fodder maize – coriander sequence at different FYM and nitrogen levels at the Agricultural College Farm, Bapatla during 2004-05. Application of FYM @ 10 t ha^{-1} significantly improved the growth attributes and green and dry fodder yields of fodder maize. Quality parameters like crude protein and total ash contents were improved significantly and crude fibre content decreased with 10 t FYM ha^{-1}. Similarly, 150 kg nitrogen ha^{-1} significantly increased the growth, fodder yield and quality of fodder maize. Dry matter production, green and seed yields of succeeding coriander were significantly increased when 10 t FYM ha^{-1} was applied to preceding fodder maize. As the nitrogen level was increasing from 60 to 150 kg ha^{-1} to preceding fodder maize, a favourable effect on succeeding coriander was noticed.

Key words : Fodder Maize – Coriander Sequence, FYM, Nitrogen Levels

Maize (*Zea mays* L.) is one of the most important economic crop plants and is almost an ideal cereal forage crop because of its quick growing, high yielding, better palatability and nutritious qualities. The average roughage yield of maize is about 40 t ha^{-1} of green fodder. Nitrogen is the most important major nutrient element for fodder maize as it increases the vegetative growth and plant's green matter production which are the twin desirable qualities of an ideal fodder crop (Girijadevi, 2002).

Role of organic manure in crop production and beneficial effect of its integration with inorganic fertilizers have drawn attention of agriculturists since long. On the other hand, continuous application of high amounts of inorganic fertilizers alone and deleterious effect leading to decline in crop productivity due to limitation of one or more nutrients (Nambiar and Abrol, 1989).

Application of FYM along with fertilizer nitrogen improves the growth, yield and nutritive value of fodder maize and also maintains soil health and productivity (Vasanthi *et. al.*, 1998). Therefore, an experiment was carried out during *kharif* and *rabi* seasons of 2004-05 at the Agricultural College Farm Bapatla to study the performance of fodder maize – coriander sequence at different FYM and nitrogen levels.

MATERIAL AND METHODS

The field experiment was conducted at the Agricultural College Farm, Bapatla during *kharif* and *rabi* seasons of 2004-05. The soil was a clay loam with 7.9 pH. It was medium in its organic carbon content (0.5%), low in available nitrogen (264 kg ha^{-1}), medium in available phosphorus (43 kg ha^{-1}) and high in available potassium status (932 kg ha^{-1}). The experimental site received 235.7 and 76.5 mm rainfall during the crop periods of fodder maize and coriander, respectively. The experiment was laid out in split plot design with three replications. Three levels of FYM (0, 5, and 10 t ha^{-1}) were in main pot treatments. Fodder maize cultivar, African Tall was sown on 16-08-2004 using 50 kg seed ha^{-1} at inter and intra-row spacing of 30 x 10 cm and harvested on 16-10-04. FYM containing 0.7% N, 0.4% P and 0.8% K was incorporated into the soil 15 days before sowing of fodder maize as per the treatments. Recommended dose of phosphorus and potassium @ 40 kg P_2O_5 and K_2O ha^{-1} each through single super phosphate and murite of potash, respectively were applied at the time of sowing of fodder maize. Nitrogen was applied in two equal splits through urea at the time of sowing and at 30 DAS as per the treatments. Fodder maize was grown by following recommended package of practices and harvested at 60 DAS. After the harvest of fodder maize, succeeding coriander was raised on the residual soil fertility status without receiving manure (or) fertilizers. For coriander, seed bed was prepared without disturbing the layout and coriander cultivar CS-4 collected from Regional Agricultural Research Station, Lam was sown @ 15 kg ha^{-1}. Data on fodder maize and succeeding coriander were collected and analysed statistically.

RESULTS AND DISCUSSION

Effect of FYM and nigrogen levels on fodder maize

Results in Table 1 revealed that the direct effect of FYM and nitrogen levels on production of fodder maize was significant. Increase in FYM level upto 10 t ha^{-1} significantly increased the drymatter production of fodder maize. Among the FYM levels tried, 10 t FYM ha^{-1} recorded significantly the highest drymatter production (8.6 t ha^{-1}). The increased availability and absorption of essential plant nutrients in FYM applied plots could be the reason for higher growth attributes which ultimately reflected in higher drymatter accumulation of fodder maize as also reported by Patel and Patel (1992).

Green and dry fodder yields of fodder maize were greatly influenced by the application of FYM levels. Each increment in the level of FYM from control to 10 t ha^{-1} significantly increased the green and dry fodder yields of fodder maize. The highest green (49.9 t ha^{-1}) and dry fodder (17.2 t ha^{-1}) yields of fodder maize were registered by applying 10 t FYM ha^{-1}, whereas the lowest green and dry fodder yields were recorded when the crop did not receive any FYM. FYM might have played a key role in enhancing the efficient utilization of the native as well as added fertilizers to fodder maize thereby created the favourable environment in rhizosphere for better expression of the physiological growth parameters which ultimately reflected interms of higher green and dry fodder yields (Choubey *et. al.* 2002).

Quality parameters like crude protein content, crude fibre content and total ash contents were also significantly influenced by FYM levels (Table 1). Crude protein content and total ash contents were significantly increased with increase in FYM level upto 10 t ha^{-1}. The highest crude protein and total ash contents (8.7 and 9.7%, respectively) and the lowest crude fibre content (26.9%) were recorded by the application of 10 t FYM ha^{-1} and the lowest crude protein and total ash contents (7.6 and 9.2, respectively) and the highest crude fibre content (31.7%) were recorded in the treatment receiving no FYM. Since the crude protein content has been calculated by multiplying the nitrogen content by 6.25, an increase in the nitrogen content of the plant with increased nitrogen supply in the growth medium due to application of FYM in combination with chemical nitrogen resulted into increased crude protein content of fodder maize. Higher uptake of minerals by the crop due to increased availability of nutrients from growth medium due to FYM application might be the reason for increased total ash content of fodder maize. The findings are in the line with the reports of Sunil Kumar *et. al.* (2004).

Application of nitrogen levels significantly influenced the drymatter production, green and dry fodder yields and also quality parameters of fodder maize. Increase in nitrogen level from 60 to 150 kg ha^{-1} significantly increased the dry matter prduction of fodder maize (9.1 t ha^{-1}), at 150 kg ha^{-1} nitrogen level. Nitrogen fertilization favourably influenced the growth parameters and their improved growth might be responsible for increased drymatter production at higher nitrogen levels.

Increase in nitrogen level from 60 to 150 kg ha^{-1}, significanty increased the green and dry fodder yields of fodder maize. The highest green and dry fodder yields (54.8 and 18.5 t ha^{-1}, respectively) were registered at the highest nitrogen level of 150 kg ha^{-1}, whereas the lowest green and dry fodder yields were recorded at 60 kg nitrogen ha^{-1}. Nitrogen being a major constituent of chlorophyll molecule, it might have accelerated the photo-synthetic activity and this favoruable impact of nitrogen might have reflected interms of higher green and dry fodder yields.

Similarly, quality parameters like crude protein content, crude fibre and total ash contents were also significantly influenced by nitrogen levels applied. The highest crude protein, crude fibre and total ash contents (8.7, 29.7 and 9.7%, respectively) were noticed with 190 kg nitrogen ha^{-1}. Application of inorganic nitrogen might have enhanced the availability of nitrogen which increased the quality of fodder maize, Choubey *et. al.* (2001) also reported similar findings.

Residual effect of FYM and nitrogen levels on succeeding coriander

Increase in the FYM level upto 10 t ha^{-1} significantly increased the drymatter production, green and seed yields of succeeding coriander. The highest drymatter production, green and seed yields (1624, 1800 and 522 kg ha^{-1}, respectively) were recorded when the preceding fodder maize received FYM 10 t ha^{-1}, while the lowest drymatter production, green and seed yields of succeeding coriander were noticed when fodder maize was not given FYM *i.e.,* control treatment. It is known to

Table 1: Effect of FYM and nitrogen levels on growth, yield and quality of fodder maize

	Dry matter production (t ha^{-1})	Green fodder yield (t ha^{-1})	Dry fodder yield (t ha^{-1})	CP content (%)	CF content (%)	Total ash content %
FYM Level (t ha^{-1})						
0	7.1	34.8	11.8	7.6	31.7	9.2
5	7.9	43.7	14.8	8.1	28.9	9.5
10	8.6	49.9	17.2	8.6	26.9	9.6
SEm+	0.1	0.5	0.17	0.02	0.06	0.008
CD (P=0.05)	0.32	1.5	0.5	0.1	0.2	0.03
Nitrogen level (kg ha^{-1})						
60	6.3	28.9	10.0	7.4	28.4	9.0
90	7.6	39.3	13.5	7.9	28.9	9.4
120	8.5	48.1	16.4	8.4	29.6	9.6
150	9.1	54.8	18.5	8.7	29.7	9.7
SEm+	0.06	0.59	0.24	0.02	0.05	0.007
CD (P=0.05)	0.2	1.9	0.8	0.1	0.2	0.02

Table 2: Growth and yield of succeeding coriander as infuenced by FYM and Nitrogen levels applied to preceeding fodder maize.

	Dry matter production (kg ha^{-1})	Green yield (kg ha^{-1})	Seed yield (kg ha^{-1})
FYM Level (t ha^{-1})			
0	1245	1325	404
5	1399	1524	461
10	1624	1800	522
SEm+	15.6	6.0	6.6
CD (P=0.05)	48	18	20
Nitrogen level (kg ha^{-1})			
60	1225	1308	398
90	1380	1494	452
120	1509	1662	492
150	1576	1734	507
SEm+	12.0	15.5	3.5
CD (P=0.05)	38	50	11

enhance the use efficiency of applied fertilizers with FYM besides improving physico-chemical properties of soil and preventing the emergence of nutrient deficiencies (Hedge, 1992). The increased residual soil fertility with the application of FYM along with improved physicochemical properties might be the reason for better dry matter production and higher green and seed yields of succeeding coriander. Similarly, increase in the application of nitrogen level upto 150 kg ha^{-1} to preceding fodder maize significantly increased the drymatter production, green and seed yields of succeeding coriander. The highest drymatter production, green and seed yields of coriander (1576, 1734 and 507 kg ha^{-1} respectively) were noticed when the fodder maize had received 150 kg nitrogen ha^{-1}, whereas the lowest drymatter production, green and seed yields were observed in the treatment that received no FYM for preceding fodder maize, as also reported by Nanda *et. al.* (2002).

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Effects of Salinity on Nitrate Reductase Activity and Proline Accumulation in Desi Cotton (*Gossypium herbaceum* L.)

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ABSTRACT

A pot culture experiment was conducted with three salinity levels (0, 4 and 8 EC levels) to know the effects of salinity on nitrate reductase activity and proline accumulation with a view to use these parameters as indices for selecting tolerant genotypes to salinity stress in herbaceum cotton. The results revealed that, in all the genotypes the nitrate reductase activity decreased whereas proline accumulation increased with increasing salinity levels. The genotypes Dhumad, Jayadher, GCot 13, GCot 17 and GCot 21 were found to be salt tolerant as they showed high nitrate reductase activity and more proline accumulation at higher salinity levels also.

Key words : Nitrate Reductase Activity (NRA), Proline Accumulation, Salinity Tolerance and Herbaceum Cotton

Soil salinity is one of the most important problems of crop production in coastal areas as well as arid and semi arid zones. In India, there are approximately 4 million hectares of salt affected land (Anonymous, 1976). It has been recorded that salinity affects growth, development and metabolism of plants, the effects varying with the plant species and the stage of development (Hasson-Porath *et. al.*, 1981). Although cotton is regarded as salt tolerant, it is relatively sensitive during germination (Carter, 1981). Among the four cultivated cotton species, *Gossypium herbaceum* L. is found to be performing well under coastal saline areas. So herbaceum cultures were taken as study material.

Under salt stress the uptake of nitrogen and the synthesis of nitrate into organic compounds are affected. Balasubramanian *et. al.* (1974) reported, crops differ in their ability to reduce nitrate under saline conditions. The proline content was higher in plants grown under saline conditions. According to Stewart *et. al.* (1966) increased proline in the plants may be an adaptation to overcome the stress conditions and proline accumulated under saline conditions supplies energy for growth and survival and there by induces salinity resistance in rice varieties (Bal, 1978). So proline accumulation has been considered as advantageous under stress, Hanson *et. al.* (1979) and Chu *et. al.* (1976). Keeping these points in view, the effects of salinity on nitrate reductase activity and proline accumulation was studied in *Gossypium herbaceum* cultures.

MATERIAL AND METHODS

Pot culture experiment was conducted at Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh during *kharif*, 2001-02. Fifteen herbaceum genotypes *viz.*, GCot 13, GCot 17, GCot 21, GCot 23, Dhumad, Jayadher, DB 3-12, RAHS 14, RAHS 132, Gcot DH7, GCot DH9, V 797, Ddhc 11 and Wagad were grown in cement pots against 3 salinity levels (0, 4 and 8 EC levels) in three replications in split plot design. The pots were uniformly filled with 18 kg of soil. The soil is black clayey in nature having a pH of 7.8, EC-0.56 dsmin^{-1}, organic carbon 0.2%, available nitrogen 115 kg/ha available phosphorus 18 kg/ha and available potassium 585 kg/ha. Two plants were maintained in each pot. Salt solutions of different concentrations were prepared as suggested by Sajjid (1988) dissolving Mg Cl_2, NaCl, $CaCl_2$ and Na_2SO_4 in distilled water in the ratio of 1:4:5:10 to give an EC of 12.5 dSm^{-1}. This solution was further diluted with different quantities of distilled water to give various values of 4 and 8 EC levels. Distilled water was used as control. These solutions were added to pots at regular intervals and pots were maintained at around desired salinities till maturity.

Data on nitrate reductase, proline in leaves and squares (Bates, 1973) were collected and statistically analysed as per Cochran (1957).

RESULTS AND DISCUSSION

In all the genotypes under study nitrate reductase activity decreased with increase in

Table 1 : Nitrate reductase activity in cotton varieties.

S.No.	Entry	0 EC	4 EC	8 EC	Mean
1	G Cot-13	5.40	4.40	3.50	4.43
2	G Cot-17	5.33	4.27	3.60	4.40
3	G Cot-21	5.23	4.13	3.12	4.18
4	G Cot-23	5.10	4.03	3.13	4.09
5	Dhumad	5.70	4.57	3.57	4.61
6	Jayadher	5.78	4.50	3.57	4.61
7	DB-3-12	5.30	4.13	3.13	4.19
8	RAHS 14	5.10	3.90	3.10	4.03
9	RAHS 132	5.27	4.10	3.20	4.19
10	G Cot DH7	5.10	3.80	3.00	3.97
11	G Cot DH-9	4.83	3.70	2.87	3.80
12	Digvijay	5.10	3.80	3.10	4.00
13	V 797	4.87	3.73	2.77	3.79
14	DDHc11	4.77	3.73	2.77	3.74
15	Wagad	4.70	3.50	3.10	3.73
	Mean	5.17	4.02	3.16	4.12
		Variety	Salinity (EC) level	Interaction (variety x EC level)	
	SEm	0.042	0.024	0.066	
	CD at 5%	0.122	0.067	0.184	
	CV (%)	2.178	2.796	2.023	

Table 2 : Proline content in leaves (micrograms per gram fresh weight) of cotton varieties.

S.No.	Entry	0 EC	4 EC	8 EC	Mean
1	G Cot-13	108.30	144.00	185.33	145.89
2	G Cot-17	106.00	142.00	181.00	143.00
3	G Cot-21	103.66	141.33	180.00	141.67
4	G Cot-23	101.00	141.33	184.67	142.33
5	Dhumad	111.33	145.33	187.67	148.11
6	Jayadher	109.33	144.00	179.33	144.22
7	DB-3-12	104.33	140.67	183.33	142.67
8	RAHS 14	101.30	140.67	176.00	139.33
9	RAHS 132	104.60	135.33	172.67	137.33
10	G Cot DH7	100.60	130.67	170.67	134.00
11	G Cot DH-9	98.30	130.00	167.67	131.78
12	Digvijay	100.00	127.30	164.00	130.44
13	V 797	96.67	129.33	167.00	131.00
14	DDHc11	96.00	127.33	166.00	129.78
15	Wagad	91.00	136.00	168.67	131.89
	Mean	102.10	137.00	175.60	138.23
		Variety	Salinity (EC) level	Interaction (variety x EC level)	
	SEm	0.800	0.330	0.904	
	CD at 5%	2.183	0.915	2.507	
	CV (%)	1.157	1.133	1.100	

Table 3 : Proline content in squares (micro-grams per gram fresh weight) of cotton varieties.

S.No.	Entry	0 EC	4 EC	8 EC	Mean
1	G Cot-13	74.67	93.00	113.00	93.56
2	G Cot-17	72.67	91.00	110.00	91.22
3	G Cot-21	74.33	93.00	112.33	93.22
4	G Cot-23	69.00	86.67	106.33	87.33
5	Dhumand	73.67	94.33	115.00	94.33
6	Jayadher	73.00	94.67	113.33	93.67
7	DB-3-12	69.33	88.67	106.67	88.22
8	RAHS 14	69.33	87.67	104.00	87.00
9	RAHS 132	65.00	88.00	109.33	87.44
10	G Cot DH7	61.33	82.67	103.67	82.56
11	G Cot DH-9	60.33	80.67	99.33	80.11
12	Digvijay	64.00	85.00	104.67	84.56
13	V 797	62.00	78.67	98.33	79.67
14	DDHc11	60.67	77.33	96.00	78.00
15	Wagad	60.67	71.67	91.33	74.56
	Mean	67.67	86.20	105.56	86.36
		Variety	Salinity (EC) level	Interaction (variety x EC level)	
	SEm	0.990	0.515	1.412	
	CD at 5%	2.853	1.428	3.912	
	CV (%)	2.420	2.831	2.800	

salinity levels. On average, irrespective of genotypes, the per cent decrease in nitrate reductase activity at 4 EC and 8 EC over control is 28.7% and 63% respectively (Table 1). The genotypes Dhumad, Jayadher, GCot 13, GCot 21 showed high nitrate reductase activity even at 8 EC indicating their tolerance to salt stress, in conformity with Lapina (1967); Balasubramanian *et. al.* (1974) and Pandey and Srivastava (1989).

Proline accumulation which is the desirable character under stress condition for tolerance increased with increase in salinity level in all genotypes in both squares and leaves (Table 2 and 3). Similar results were also reported by Palfi and Juhasz (1968) in rice, Pathak *et. al.* (1974) in wheat, Bal *et. al.* (1978) in rice, Greenway and Munns (1980), Chaudhuri *et. al.* (1997) in barley.

In the present study, proline content was found more in leaves than in squares. Among the fifteen *Gossypium herbaceum* genotypes, Dhumad, Jayadher, GCot 21 and GCot 17 accumulated more proline under all three salinity levels in both leaves and squares. The percent increase in proline content was highest in Dhumad, Jayadher, RAHS 132, GCot DH7, GCot DH9 and Digvijay at 4 EC and 8 EC over control.

The present study indicates that the genotypes *viz.*, Dhumad, Jayadher, GCot 13, GCot 17 and GCot 21 having high nitrate reductase activity and higher proline accumulation both in leaves and squares at 4 and 8 EC levels are having high tolerance to salt stress and hence can be recommended for salt stressed areas or they can be used as the parent material in future breeding programmes.

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Correlation and Path Analyses in Maize

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ABSTRACT

Genotypic and phenotypic correlation studies in maize indicated that plant height, ear height, tassel length, chlorophyll content, leaf area index and total biomass were positively associated with grain yield. Leaf area index exhibited high genotypic correlation than phenotypic correlation. Path coefficient analysis revealed that total biomass followed by leaf area index, chlorophyll content, plant height, days to 50% silking, anthesis-silking interval and days to 50% maturity contributed directly towards grain yield per plant. Though the character anthesis-silking interval had direct positive contribution towards grain yield, it had indirect negative influence through days to 50% tasselling, days to 50% silking, ear height and tassel length. Effective kernel filling period and days to 50% tasselling exhibited negative influence both directly and indirectly.

Key words : Correlation, Path Analysis, Maize, *Zea mays* L.

Grain yield in maize (*Zea mays* L.) is a complex character controlled by many factors. It is also one of the such dependent traits which is influenced by many independent characters. Understanding the relationship among yield and yield components is of paramount importance in making the best use of selection. The correlation coefficient may be confounded by direct and indirect effects due to common inherent association among different characters. Therefore, information derived from the correlation coefficients can be augmented by partitioning correlations into direct and indirect effects by path-coefficient analysis. The objective of the resent investigation was to study the relationship between yield and physiological traits to estimate the direct and indirect effects of the component characters on grain yield.

MATERIAL AND METHODS

The experimental material comprised a set of diallel crosses excluding reciptrocals made at Agricultural Research Station (Maize), Amberpet Farm, Hyderabad during *kharif* 2001 involving 10 diverse inbred lines of maize (P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, and P_{10}). Ten parents and their hybrids were grown in randomized block design with three replications at College Farm, College of Agriculture, Rajendranagar, Hyderabad during *rabi* 2001-02. Each plot consisted of single row of 5 m length with inter- and intra- row spacing of 75 x 25 cm, respectively. The data were recorded on days to 50% tasselling, days to 50 silking, days to 50% maturity, plant height (cm), ear height (cm), anthesis-silking interval (days), effective kernel filling period (days), tassel length (cm), chlorophyll content (mg/g), leaf area index (LAI), total biomass per plot (kg) and grain yield per plot (kg).

Data on days to 50% tasselling, days to 50% silking, days to 50% maturity, anthesis-silking interval, effective kernel filling period, total biomass and grain yield were recorded on plot basis, while other characters were recorded on 10 randomly selected plants and averaged. Chlorophyll content and leaf area index were estimated by DMSO method and LI-3100 Area meter (LICOR-Lincoln, Nebraska, USA) respectively. Correlation coefficients were calculated using the method given by Snedecor and Cochran (1967) and path-coefficients as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that genotypic correlations were slightly higher in magnitude than phenotypic ones. The low phenotypic correlations could have resulted due to the modifying effect of environment on the association of characters at the genotypic level. There was a general agreement in both sign and magnitude between the estimates of genotypic and phenotypic correlations. However, characters which were genotypically but not phenotypically correlated may not be of practical value in selection since selection is based on phenotype as observed in case of relationship between plant height and grain yield.

Grain yield per plant was significantly and positively associated with plant height, ear height, tassel length, chlorophyll content, leaf area index and total biomass (Laptev, 1981; Sharma *et. al.*, 1982; Adhikari *et. al.*, 1989; Li Yuling, 1997; Jain *et. al.*, 1976; Krishnan and Natarajan, 1995; Gautam *et. al.*, 1999). Total biomass exhibited highest positive correlation with grain yield followed by chlorophyll content, leaf area index, tassel length, ear height and plant height. All possible associations among these characters were positive and significant except anthesis-silking interval. Leaf area index exhibited significantly higher genotypic correlations than phenotypic correlations in its combination with all other characters indicating high masking effect of environment on this character. Days to 50% tasselling, days to 50% silking, days to 50% silking, days to 50% maturity and effective kernel filling period exhibited significantly negative correlations with grain yield. Path coefficient analysis was carried out to find the direct and indirect influences of the yield contributing characters towards grain yield (Table 2).

Table 1 : Phenotypic and genotypic correlations of yield and yield components

Characters	Days to 50% silking	Days to 50% maturity	Plant height	Ear height	Anthesis-silking interval	Effective kernel filling period	Tassel length	Chlorophyll content	Leaf area index	Total biomass	Grain yield
Days to 50% tasselling	0.920** (0.921**)	0.829** (0.838**)	-0.518 (-0.519)	-0.290 (-0.298)	-0.190 (-0.205)	0.138 (0.155)	-0.545* (-0.567*)	-0.664** (-0.667**)	-0.699** (-0.709**)	-0.645** (-0.654**)	-0.670**
Days to 50% silking		0.849** (0.849**)	-0.431 (-0.441)	-0.193 (-0.201)	0.165 (0.169)	0.058 (0.062)	-0.471 (-0.491)	-0.590* (-0.596*)	-0.598* (-0.599*)	-0.590* (-0.590*)	-0.603**
Days to 50% maturity			-0.655** (-0.665**)	-0.354 (-0.381)	0.020 (0.021)	0.564* (0.577*)	-0.670** (-0.690**)	-0.845** (-0.857**)	-0.822** (-0.831**)	-0.836** (-0.845**)	-0.654**
Plant height				0.838** (0.837**)	0.168 (0.168)	-0.548* (-0.571*)	0.983** (0.985**)	0.846** (0.846**)	0.812** (0.854**)	0.794** (0.794**)	0.590**
Ear height					0.179 (0.179)	-0.349 (-0.367)	0.833** (0.834**)	0.623** (0.623**)	0.604** (0.675**)	0.567** (0.588**)	0.592**
Anthesis-silking interval						-0.196 (-0.220)	0.172 (0.168)	0.216 (0.225)	0.194 (0.216)	0.169 (0.169)	0.204
Effective kernel filling period							-0.504 (-0.541)	-0.656** (-0.683**)	-0.604* (-0.653*)	-0.642** (-0.664**)	-0.657**
Tassel length								0.869** (0.890**)	0.835** (0.880**)	0.821** (0.840**)	0.654**
Chlorophyll content									0.923** (0.926**)	0.973** (0.994**)	0.852**
Leaf area index										0.908** (0.910**)	0.749**
Total biomass											0.979**

Values in parentheses are genotypic correlations *, ** Significant at P=0.05 and P=0.01 level, respectively

The values of residual path after deducing the direct and indirect effects were low. All the direct effects were less than one, indicating the minimum inflation due to multicolinearity (Gravois and Helms, 1992). The analysis of results indicated that the chracters plant height, anthesis-silking interval, tassel length, chlorophyll content, leaf area index and total biomass had positive contribution towards grain yield both directly and indirectly (Dornescu, 1980; Sharma and Kumar, 1987). Total biomass exhibited highest positive direct influence on grain yield followed by leaf area index, chlorophyll content, plant height, days to 50% silking, anthesis-silking interval and days to 50% maturity.

Though ear height and tassel length had a strong correlation with grain yield, it exhibited a direct negative genotypic effect and a weak positive phenotypic effect. The high correlation of this character was due to its positive indirect effects on grain yield through other characters. Inspite of its high direct positive influence on grain yield the character anthesis-silking interval had a weak correlation. This was mainly due to its negative indirect effects through days to 50% tasselling, days to 50% silking, ear height and tassel length. There was a compensatory effect between these characters and anthesis-silking interval. Days to 50% tasselling and effective kernel filling period displayed negative influence on grain yield both directly and indirectly. Ear height exhibited highest direct negative influence on grain yield. There was a compensatory effect between grain yield and ear height.

Further, analysis revealed that the characters days to 50% tasselling, days to 50% silking, plant height, anthesis-

Table 2: Path coefficient analysis showing direct and indirect effects of different characters on grain yield

Characters	Days to 50% tasselling	Days to 50% silking	Days to 50% maturity	Plant height	Ear height	Anthesis-silking interval	Effective kernel filling period	Tassel length	Chlorophyll content	Leaf area index	Total biomass	Correlation with grain yield
Days to 50% tasselling	**-0.047**	-0.109	0.001	-0.082	0.001	-0.009	-0.011	0.050	-0.136	-0.151	-0.159	-0.670**
	(0.056)	-0.112	(0.022)	(-0.069)	(0.003)	(-0.007)	(-0.005)	(0.053)	(-0.156)	(-0.060)	(-0.136)	
Days to 50% silking	-0.123	**0.102**	0.097	-0.182	-0.007	0.010	-0.001	0.036	-0.173	-0.050	-0.276	-0.603**
	(-0.144)	**0.130**	(0.106)	(-0.158)	(-0.009)	(0.009)	(-0.002)	(0.046)	(-0.185)	(-0.063)	(-0.245)	
Days to 50% maturity	-0.110	-0.011	**0.000**	-0.062	0.003	0.003	-0.20	0.001	-0.173	-0.039	-0.143	-0.654**
	(-0.129)	-0.025	**(0.002)**	(-0.088)	(0.005)	(0.001)	(-0.023)	(0.006)	(-0.181)	(-0.041)	(-0.177)	
Plant height	0.074	0.026	-0.001	**0.129**	0.001	0.004	0.020	-0.064	0.179	0.040	0.170	0.590**
	(0.079)	0.029	(-0.009)	**(0.135)**	(0.004)	(0.009)	(0.023)	(-0.064)	(0.182)	(0.030)	(0.168)	
Ear height	0.035	0.001	-0.004	0.122	**0.009**	0.016	0.014	-0.004	0.133	0.059	0.221	0.592**
	(0.045)	0.004	(-0.002)	(0.113)	**(-0.083)**	(0.010)	(0.014)	(-0.001)	(0.129)	(0.061)	(0.220)	
Anthesis-silking interval	-0.012	-0.002	-0.001	0.022	0.007	**0.047**	0.006	-0.001	0.151	0.021	0.040	0.240
	(-0.029)	-0.008	(0.001)	(0.022)	(0.008)	**(0.057)**	(0.008)	(-0.011)	(0.149)	(0.021)	(0.036)	
Effective kernel filling period	-0.011	-0.001	-0.001	-0.182	0.005	-0.001	**0.047**	0.001	-0.162	-0.127	-0.129	-0.657**
	(-0.021)	-0.003	(0.001)	(-0.174)	(0.006)	(-0.009)	**(-0.042)**	(0.009)	(-0.151)	(-0.137)	(-0.136)	
Tassel length	-0.001	0.006	-0.001	0.099	-0.001	0.004	0.019	**0.001**	0.176	0.105	0.223	0.654**
	(-0.005)	0.008	(-0.001)	(0.103)	(-0.006)	(0.010)	(0.021)	**(-0.008)**	(0.198)	(0.108)	(0.225)	
Chlorophyll content	0.100	0.110	-0.017	-0.110	0.001	0.009	0.023	0.001	**0.180**	0.132	0.203	0.852**
	(0.104)	0.100	(-0.026)	(0.104)	(0.009)	(0.012)	(0.027)	(-0.005)	**(0.187)**	(0.143)	(0.206)	
Leaf area index	0.093	0.003	-0.001	0.130	0.001	0.003	0.023	-0.023	0.132	**0.213**	0.180	0.749**
	(0.109)	0.007	(-0.004)	(0.110)	(0.003)	(0.011)	(0.025)	(-0.032)	(0.134)	**(0.200)**	(0.192(	
Total biomass	0.093	0.112	-0.020	0.202	0.001	0.002	0.025	-0.019	0.157	0.133	**0.215**	0.979**
	(0.101)	0.105	(-0.015)	(0.207)	(0.007)	(0.009)	(0.027)	(-0.020)	(0.169)	(0.141)	**(0.216)**	

Residual effect (genotypic = 0.128264; Residual effect (phenotypic) = 0.160198; Values in parentheses are genotypic effects; Bold figures are direct effects.

silking interval, effective kernel filling period, chlorophyll content, leaf area index and total biomass had indirect positive influence on grain yield via ear height. Hence, indirect selection criteria in the form of selection indicies involving the above characters would be more effective in early generations to isolate desirable transgressive segregants for grain yield.

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Correlation and Path Analyses among Floral Characters of Drought Resistant Cultures of Rice

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ABSTRACT

Twenty five drought resistant cultures were raised at Agricultural College and Research Institute, Killikulam in randomized block design and replicated thrice and the relationship between seven characters namely ovary length, ovary width, style length, stigma length, anther length, anther width, filament length with pollen fertility was compared through correlation and path analyses. Correlation studies revealed that ovary length has positive and significant association with pollen fertility. Ovary length, stigma length, anther width and filament length has positive direct effect on pollen fertility. However, only ovary length has positive significant association with pollen fertility. Hence selection of spikelets based on ovary length will increase the pollen fertility

Key words :

Rice, the most important food crop in India occupies 44.0 million hectares, the largest rice area in the world. Compared to yield of irrigated rice, production and productivity of rice under rainfed condition is very low. In rice, global loss due to drought was estimated as high as $3.51 billion annually (Michael Gomez *et. al.*, 2003). Hence, drought resistant varieties with increased yield must be developed in order to meet the demands of ever increasing population. Hybrid production is the most important method in plant breeding programme to develop new varieties. But hybridization programme is very difficult in self-pollinated crops like rice because of low seed setting percentage. Hence, the present study was conducted on correlation among different floral characters with pollen fertility and inter relationship.

MATERIAL AND METHODS

This present investigation was done at Agricultural College and Research Inistitute, Killikulam. Twenty five drought resistant cultures were raised in randomized block design and replicated thrice. Five plants were selected at random for every genotype of each replication for recording observation. Observations recorded include floral characters like ovary length, ovary width, style length, stigma length, anther length, anther width, filament length and pollen fertility. Twenty five genotypes were evaluated for eight floral characters through statistical analysis. Correlation studies were carried out as suggested by Johnson *et. al.* (1955) and path analysis by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Phenotypic coefficient variability (PCV) was higher than genotypic coefficient variability (GCV) for all the floral characters. There is a minimum difference between PCV and GCV for the characters *viz.*, ovary width, style length, stigma length and pollen fertility in all the 24 drought resistant cultures. High heritability was observed for the floral characters like style and stigma length and pollen fertility and this indicates that selection based on phenotypic level will be effective for these traits. According to Lush (1949) selection based on heritability and genetic advance is more important for selection than heritability alone. High heritability combined with high genetic advance was observed for style length and filament length in drought resistant cultures. These results indicate the preponderance of additive genes.

Simple correlation among different floral characters indicate that the ovary length has negative association with style length and positive association with pollen fertility. Ovary width has positive significant association with style length, anther width and negative significant association with pollen fertility. Style length has positive significant association with stigma length, anther width, filament length, and negative significant association with pollen fertility. Stigma length is positively and significantly associated with anther length, anther width and filament length. Anther width is correlated with filament length positively and significantly. These results indicate that only ovary length has positive and significant association with pollen fertility.

Table 1: Genetic parameters for differetn floral traits in drought tolerant rice cultures.

	Genotypic coefficient of variation	Phenotypic coefficient of variation	Environmental coefficient of variation	Heritability	Genetic advance as % of mean
Ovary length	7.72	10.58	7.23	53.29	11.61
Ovary width	4.64	6.52	4.57	50.77	6.82
Sytle.length	24.27	26.16	9.77	86.06	46.39
Stigma length	16.04	18.17	8.53	77.94	29.18
Anther length	10.81	13.02	7.27	68.84	18.47
Anther width	14.48	21.31	15.64	46.16	20.27
Filament length	19.95	24.50	14.21	66.34	33.48
Pollen fertililty	5.74	6.15	2.20	87.16	11.05

Table 2: Estimates of simple correlation coefficient between pollen fertility and other floral characters in drought tolerant rice cultures.

	Ovary width	Sytle length	Stigma length	Anther length	Anther width	Filament length	Pollen fertililty
Ovary length	-0.234	-0.440*	-0.170	0.201	-0.386	-0.077	0.585**
Ovary width		0.399*	-0.026	-0.199	0.405*	0.034	-0.417*
Sytle length			0.578**	0.096	0.563**	0.522**	-0.580**
Stigma length				0.585**	0.470*	0.645**	-0.169
Anther length					0.332	0.414*	0.177
Anther width						0.249	-0.381
Filament length							-0.150

Table 3: Direct and indirect effects of seven floral characters on pollen fertility in rice.

	Ovary length	Ovary width	Sytle length	Stigma length	Anther length	Anther width	Filament length	Correlation with pollen fertililty
Ovary length	**0.878**	0.097	0.490	-0.113	-0.182	-0.413	-0.048	0.585**
Ovary width	-0.304	**-0.280**	-0.441	-0.026	0.175	0.392	0.004	-0.417*
Sytle length	-0.434	-0.125	**-0.992**	0.279	-0.096	0.534	0.222	-0.580**
Stigma length	-0.216	0.016	-0.602	**0.461**	-0.506	0.413	0.265	-0.169
Anther length	0.208	0.064	-0.124	0.303	**-0.767**	0.306	0.187	0.177
Anther width	-0.467	-0.141	-0.682	0.245	-0.303	**0.777**	0.075	-0.381
Filament length	-0.105	-0.003	-0.551	0.304	-0.359	0.145	**0.401**	-0.150

Bold and underlined figures are direct effects.

Further partitioning of genotypic correlation into direct and indirect effects were done through path coefficient analysis. Ovary length, stigma length, anther width and filament length had positive direct effect on pollen fertility. Ovary width, style length, anther length had negative direct effect on pollen fertility and hence these characters contribute to pollen fertility through other floral characters.

Ovary length has positive significant association with pollen fertility besides had positive direct effect on pollen fertility. Hence selection of spikelets with increased ovary length will increase the pollen fertility. Hence selection of parental varieties based on increased ovary length will increase the pollen fertility, thereby increasing the seed setting percentage resulting in better seed production in rice hybrids.

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Variability, Heritability and Genetic Advance in F_2 Generation of India Mustard [*Brassica juncea* (L) Zern and Coss]

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ABSTRACT

Genetic variability, heritability and genetic advance for 13 characters were obtained from 28 crosses of Indian mustard. Significant differences were obtained for all the characters indicating the diverse genetic nature of the crosses under study. The highest GCA and PCA was observed in days to 50% flowering, secondary branch / plant, number of siliquae/plant and test weight. High heritability combined with high genetic advance as per cent of mean were observed in seed yield / plant, plant height, secondary branch / plant, number of siliquae / plant and test weight indicating the involvement of additive genes in their expression and possibility of improving these characters through selection.

Key words : Heritability, Indian Mustard.

Rapeseed-mustard occupies forth position in the production of oilseeds in the state of Orissa and second position in India. Since the inception of Oilseed Technology Mission (1995-96) the production and productivity had gone up to 83,000 tonnes and 495 kg/ha, respectively in the state. After that the production and productivity were drastically reduced due to narrow genetic base. F_2 generation provides as active breeding material for selection of desirable plants. The present study was undertaken to estimate the extent of variability, heritability and genetic advance in F_2 generation for yield and its yield components.

MATERIAL AND METHODS

Eight varieties of diverse genetic origin were crossed in non-reciprocal diallel design during *rabi* 2001-02 at Central Research Station, Orissa University of Agricultural Technology, Bhubaneswar. The seeds of F_2 generation collected from F_1 generation, were sown in the month of October 2003-04 in a randomized block design with 4 replications. Recommended agronomic practices were followed. At the maturity individual plants were harvested from each cross of F_2 population for recording the observations to minimize the environmental effects on filed parameters. Data on thirteen yield attributing traits from the mean of 20 plants of each cross were recorded to estimate the phenotypic and genotypic coefficient of variation as per the formula obtained by Falconer (1981), heritability of Allard (1960) and genetic advance by Burton (1952).

RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the crosses for thirteen characters (Table 1). There was wide range of variability in thirteen characters. The mean performance of 28 crosses for thirteen characters (Table 2) indicated that the cross Pusa Bahar x Kranti gave highest seed yield followed by Pusa Bahar x Varuna and Varuna x Kranti. The early duration was observed in RH 30 x Pusa Jaikisan followed by Pusa Jaikisan x Agrani and RH 30 x Agrani. Similarly, late duration was observed in Pusa Bold x Pusa Bahar followed by Varuna x Kranti and Pusa Bahar x Varuna. The crosses are found medium to medium-late duration. The tallest and shortest plant heights were recorded in Pusa Bahar x Kranti and Pusa Bold x Pusa Jaikisan, respectively. Highest primary and secondary branches were observed in Pusa Bold x Pusa Bahar and Pusa Bahar x Kranti, respectively. Number of siliquae per main stem was highest in Pusa Bahar x Kranti. The longest main stem branch was observed in Pusa Bahar x Kranti. The cross, RH 30 x Kranti produced longest siliqua whereas Pusa Jaikisan x Vardan produced shortest siliqua. Variation for number of seeds per siliqua which is considered as proportionate to siliqua length, was high and varied in each cross, being highest in cross population of Kranti x Agrani followed by Pusa Bahar x Kranti, Pusa Bahar x Varuna and Varuna x Kranti and lowest in RH 30 x Vardan. Hence, it is suggested that during selection emphasis should be given for number of seeds per siliqua instead of siliqua length as also reported by Chauhan and Singh (1984) in soybean. Highest number of siliquae per plant was observed in Varuna x Kranti followed by Pusa Bahar x Kranti and Pusa Bahar x Varuna. Pusa Bold x RH 30 was the highest whereas Pusa Jaikisan x Vardan was the lowest in test weight. The cross Pusa Bahar x Varuna exhibited highest percentage of content whereas Pusa Bold x Jaikisan showed lowest in oil content. Days to

Table 1: ANOVA for thirteen quantitative characters in mustard cultures.

Source	d.f.	Days to 50% flowering	Days to maturity	Plant height (cm)	Main stem length	No. of siliquae / M.S.	Primary branches / plant	Secondary branches / plant	Siliqua length (cm)	No. of seeds / siliqua	No. of siliquae / plant	Test weight (g)	Seed yield / plant	Oil content (%)
Replication	3	25.25	23.58	458.29	96.85	90.54	3.75	13.58	2.81	6.27	434.00	3.21	24.55	24.30
Treatment	27	8.08**	14.66**	310.33**	32.89**	29.77**	2.93*	16.04**	2.40*	3.97**	771.94**	2.30*	8.37**	4.58*
Error	81	0.07	0.96	2.60	0.78	0.77	0.03	0.23	0.01	0.03	1.41	0.01	0.06	0.13
CD (P=0.05)		0.37	1.41	2.89	1.29	1.27	0.25	0.70	0.14	0.25	1.72	0.02	0.35	0.53
CV (%)		0.64	1.08	1.23	1.97	2.01	3.17	6.79	2.05	1.52	0.97	2.00	3.66	0.94

*, ** - Significant at 5% and 1% level, respectively

Table 2: Mean performance of 28 crosses of Indian mustard for 13 different cultures.

Name of the cross	Days to 50% flowering	Days to maturity	Plant height (cm)	Main stem length	No. of siliquae / M.S.	Primary branches / plant	Secondary branches / plant	Siliqua length (cm)	No. of seeds / siliqua	No.of siliequae/ plant	Test weight (g)	Seed yield / plant	Oil content (%)
Pusa Bold x Pusa Bahar	43.12	94.12	134.95	48.38	43.50	6.35	8.75	5.40	11.75	117.85	5.65	7.82	40.00
Pusa Bold x RH-30	39.12	89.12	126.07	43.35	42.25	5.40	5.05	4.75	9.15	97.00	5.70	5.08	38.28
Pusa BoldxPusa Jaikisan	39.75	89.75	113.07	45.62	44.62	5.43	7.32	4.40	10.38	106.50	4.75	5.30	37.12
Pusa Bold xVaruna	42.38	93.38	134.88	44.75	43.75	5.20	5.50	4.57	10.40	113.12	5.38	6.33	39.70
Pusa Bold x Kranti	42.25	93.25	137.40	49.33	48.25	5.03	9.88	5.00	11.65	124.50	5.47	7.97	40.85
Pusa Bold x Vardan	42.38	93.38	132.95	44.95	43.88	4.98	8.18	4.65	10.07	111.25	5.62	6.32	38.83
Pusa Bold x Agrani	41.25	91.25	126.25	41.67	40.67	4.70	4.00	4.70	11.32	131.12	4.45	6.68	37.80
Pusa Bahar x RH-30	39.90	89.90	129.45	44.45	42.33	4.55	4.25	4.80	10.15	107.18	5.43	5.92	38.45
Pusa BaharxP.Jaikisan	40.75	90.75	119.18	45.50	43.50	4.95	7.12	4.35	10.57	119.50	4.60	5.80	40.28
Pusa Bahar xVaruna	42.50	93.50	141.62	48.83	47.83	5.68	9.12	4.90	12.20	141.57	5.53	9.57	40.88
Pusa Bahar x Kranti	42.12	93.12	146.50	50.88	49.62	6.12	11.05	5.00	12.15	143.32	5.62	9.82	40.25
Pusa Bahar x Vardan	41.75	92.75	136.88	47.08	45.08	5.62	9.00	4.85	11.02	128.27	5.00	7.07	39.45
Pusa Bahar x Agrani	40.38	90.38	127.88	45.00	44.00	5.05	6.65	4.93	11.82	132.35	4.78	7.53	39.55
RH-30 x Pusa Jaikisan	37.88	87.88	116.50	41.75	39.75	4.45	4.68	4.52	9.57	105.62	4.25	4.32	37.55
RH-30 x Varuna	41.12	91.12	135.95	44.35	42.35	4.57	5.85	4.95	9.65	108.18	5.48	5.43	38.62
RH-30 x Kranti	40.83	90.82	138.45	49.12	46.12	4.75	9.25	5.57	10.82	122.10	4.77	6.32	38.88
RH-30 x Vardan	40.12	90.12	133.68	44.45	42.45	4.90	6.00	4.70	9.07	103.88	5.30	5.00	37.38
RH-30 x Agrani	38.25	88.25	125.75	41.38	40.38	4.57	4.32	4.40	10.65	119.27	4.40	5.68	37.25
Pusa Jaikisan x Varuna	41.12	91.12	126.73	41.62	40.62	4.57	6.60	4.32	10.40	115.68	4.28	5.20	39.08
Pusa Jaikisan x Kranti	41.38	91.38	124.52	45.88	44.88	5.50	7.50	4.73	10.60	121.85	4.45	5.70	38.80
Pusa Jaikisan x Vardan	40.75	90.75	125.70	43.20	42.12	4.97	6.60	4.25	9.95	110.90	3.95	4.40	37.38
Pusa Jaikisan x Agrani	38.12	88.12	114.38	39.50	38.50	4.65	4.55	4.35	11.75	118.02	3.80	5.30	38.75
Varuna x Kranti	43.00	94.00	144.12	46.55	45.55	4.85	10.57	5.07	12.27	152.80	4.85	9.12	39.57
Varuna x Vardan	42.38	93.38	139.52	42.50	41.50	4.50	6.90	4.60	10.50	138.25	4.43	6.47	38.45
Varuna x Agrani	41.00	91.00	134.20	43.72	42.72	5.12	7.07	4.90	11.82	130.50	4.50	6.98	38.50
Kranti x Vardan	42.38	93.38	142.20	47.08	45.95	5.10	9.57	4.82	11.97	135.15	4.50	7.30	38.75
Kranti x Agrani	41.25	91.25	134.82	48.12	47.12	4.82	7.88	4.82	12.57	141.57	4.30	7.68	38.42
Vardan x Agrani	40.38	90.38	125.82	41.50	40.50	4.70		4.40	11.75	126.55	4.12	4.00	37.65

50% flowering, secondary branch per plant, number of siliquae per plant and test weight showed high PCV and GCV estimates (Table 3). This suggests that the selection based on these characters would facilitate successful isolation of desirable types. Similar findings were reported by Ramana *et. al.* (2000) and Chauhan and Singh (1984) in soybean. The PCV was higher than the GCV for all the characters studied (Table 3) in agreement with Kumar and Singh (1987), Chahota and Sharma (1993) and Srinivasa Rao *et. al.* (2002). The estimates of PCV and GCV for thirteen characters (Table 3) showed little differences indicating the greater roll of genetic factors in influencing the expression of these characters offering ample scope for improvement. This was also supported by high value for heritability for these characters in agreement with Borde and Patil (1997) in niger. High heritability was observed in all the characters studied which indicated that the charactes were largely governed by additive genes as also reported by Chauhan and Singh (1984) and Ramana *et. al.* (2000). The genetic advance as percentage of mean (Table 2) was high for seed yield per plant, plant height, number of secondary branch per plant, number of siliquae per plant and test weight. These characters also recorded high heritability. This estimation shows that genotypic variance for these characters is probably owing to high additive gene effects (Johnson *et. al.*, 1955). High heritability coupled with low genetic advance as per cent of mean was recorded for days to maturity, percentage of oil content, days to 50% flowering indicating that the scope for improving these characters through selection is very limited which may be attributed to the non-additive gene effects on these traits (Johnson *et. al.*, 1955). This confirms that high heritability alone does not signify an increased genetic advance. Hence, selection based on five characters such as days to 50% flowering, plant height, secondary branch / plant and test weight/plant would help in identifying better genotypes for high seed yield.

Table 3: Mean, range, coefficient of variation, heritability and genetic advance for 13 characters in F_2 selection of mustard.

Characters	Mean	Range		Coefficient of variation		Heritability	Genetic advance as per cent of mean
		Minimum	Maximum	Phenotypic	Genotypic		
Seed yield / plant (g)	6.51	4.32	9.82	22.44	22.14	0.97	48.14
Days to 50% flowering	41.01	37.88	43.12	3.51	3.45	0.97	8.28
Days to maturity	91.28	87.88	94.12	2.29	2.03	0.78	4.61
Plant height (cm)	131.05	116.50	146.50	6.80	6.69	0.97	16.59
Main stem (MS) length (cm)	42.05	39.50	50.88	6.59	6.29	0.91	14.07
Number of siliquae/MS	43.56	38.50	49.62	6.50	6.18	0.90	12.62
Primary branch/plant	5.04	4.45	6.35	9.96	9.44	0.90	20.00
Secondary branch/plant	7.11	4.00	10.57	28.77	27.96	0.94	55.21
Siliqua length (cm)	4.74	4.25	5.57	6.91	6.60	0.91	13.82
Number of seeds / siliqua	10.93	9.07	12.57	9.21	9.08	0.97	20.21
Number of siliquae / plant	122.28	97.00	141.57	11.39	11.35	0.99	24.12
Test weight (g)	4.82	3.80	5.65	11.96	11.79	0.97	30.37
Percetnage of oil content	38.80	37.12	40.88	2.86	2.71	0.89	5.87

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Correlation and Path Coefficient Analyses of Seed, Plant Growth, Quality and Yield Characters in Rice (*Oryza sativa.* L.)

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ABSTRACT

Thirty rice genotypes were evaluated during *kharif* 2002 to study the nature and extent of relationship among seed, plant growth, quality and yield characters in cultivated rice (*Oryza sativa* L.) Relative Growth Rate (RGR) exhibited positive association with protein content and rate of germination. Rate of germination showed positive association with biomass production plant^{-1}, RGR and plant height at 15 days interval upto panicle initiation stage indicating that higher rates of germination produce more vigorous seedlings leading to accumulation of more biomass, increase in RG and plant height. Test weight had positive association with biomass production plant^{-1}, plant height, rate of germination, number of grain panicle^{-1} and grain yield plant^{-1} indicating efficient partition of photosynthates to grains and finally increasing the grain yield. RGR had negative direct effect and negative correlation with grain yield. Plant height showed positive direct effect and positive association with grain yield. Rate of germination had positive direct effect on grain yield and had indirect effect via number of productive tillers plant^{-1}, panicle length and protein content, test weight and number of grains panicle^{-1}. Number of grains panicle^{-1} had positive direct effect which was approximately equal to its correlation coefficient with grain yield.

Key words : Correlation, Direct Effect, RGR, Biomass, Rice

Seed growth characters, physiological efficiency of the plant, yield components and grain quality characters including protein content need to express synergetic effect for increasing rice productivity. The knowledge of correlation among the traits and the direct and indirect affect of all characters on the grain yield ultimately helps involving potential rice genotypes with desirable characters.

MATERIAL AND METHODS

The experiment was conducted at Agricultural College Farm, Bapatla during *kharif* 2002 using thirty rice genotypes received from Rice Research Unit, Bapatla. It was laid out in complete randomized block design with three replications. Thirty day old seedlings were transplanted at the rate of 2, 3 seedlings per hill adopting a spacing of 20 x 15 cm. The plot size was 16 m^2. The recommended package of practices for higher yields was adopted during the crop period. The data of morphological and physiological characters were recorded on five randomly selected plants in central rows in each and every genotype in all three replications. Observations on biomass production plant^{-1} (g), relative growth rate (RGR g/g/day) and plant height were taken at 15 days interval (i.e., 15, 30, 45 and 60 DAT). Boot leaf samples taken at flowering stage were utilized to estimate the nitrogen content following the Micro Kjeldahl method using Kelplus. Lowry's method was used to estimate the protein content of the grain samples. Rate of germination was calculated as per the Bewley and Black (1985). The mean data were subjected to statistical analysis. The correlation coefficients were estimated as per Falconer (1964) and path coefficient analysis was done as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Genotypic correlation coefficients were in general higher than the corresponding phenotypic correlation coefficients (Table 1). Grain yield showed significant positive correlation with 100 grain weight and number of grains planicle^{-1} at both genotypic and phenotypic levels. RGR exhibited significant positive correlation with protein content and rate of germination while negative significant association with 100 grain weight. Plant height showed significant positive correlation with biomass production plant^{-1}, panicle length and 100 grain weight at both genotypic and phenotypic levels. Rate of germination had negative significant correlation with number of productive tillers plant^{-1} at genotypic level. This result suggests that there should be an optimum plant height to have good biomass, lengthy panicles and heavy grains to obtain more grain yield. Days to 50% flowering had significant positive correlation with panicle length and negative significant correlation with rate of germination at genotypic level. Leaf N at boot leaf stage showed significant positive correlation with L/B ratio at both levels and negative significant correlation with 100 grain weight at

Table 1:Estimation of phenotypic and genotypic correlation coefficients between seed, growth and yield characters for 30 genotypes of rice

	RGR upto P-I	Plant height upto P-I	Days to 50% flowering	Leaf N Boot leaf (%)	No. of productive tillers / plant	Panicle length (cm)	L/B ratio	Protein content (%)	Rate of germination (%)	100 grain wt. (g)	No. of grains / panicle	Grain yield / plant
Biomass at 15 days interval upto P-I stage (g)	0.0790	0.6082**	0.0233	0.0079	-0.2115	0.1224	-0.2264	-0.1287	0.3053	0.3492*	0.1958	0.2131
	0.0797	0.6145**	0.0246	0.0052	-0.2173	0.1845	-0.2522	-0.1299	0.4935**	0.3602*	0.2076	0.2223
RGR at 15 days interval upto P-I stage (g/g/day)		-0.0615	0.0238	0.1749	0.0855	0.0960	0.1011	0.4338*	0.4441*	-0.3891*	-0.1296	-0.1978
		-0.0639	0.0234	0.1941	0.0864	0.1589	0.1650	0.4640**	0.8912**	-0.4321**	-0.1491	-0.1929
Plant height at 15 days interval upto P-I stage			0.0041	0.0272	-0.3285	0.4398**	0.0096	-0.2758	0.2571	0.4251*	0.2405	0.3012
			0.0050	0.0328	-0.3411*	0.6411**	0.0080	-0.2777	0.4257*	0.4342*	0.2548	0.3137*
Days to 50% flowering				-0.0496	0.1618	0.2626	-0.0064	-0.2436	-0.3013	-0.2790	-0.1990	-0.1711
				-0.0573	0.1629	0.3692*	-0.0052	-0.2447	-0.4839**	-0.2849	-0.2099	-0.1715
Leaf N boot leaf stage (%)					0.0306	-0.0102	0.4620**	0.2047	0.0396	-0.3227	-0.1707	-0.1959
					0.0302	-0.0435	0.5653**	0.2129	0.1316	-0.3437*	-0.1751	-0.2010
No. of productive tillers per plant						0.0272	0.1536	0.1728	-0.1874	-0.5746**	-0.2570	-0.3118
						0.1025	0.1635	0.1794	-0.3199	-0.6161**	-0.3085	-0.3346*
Pancile length (cm)							0.0641	-0.0973	0.0490	0.0821	0.1195	0.1502
							0.0908	-0.1390	0.1584	0.1414	0.2106	0.2599
L/B ratio								-0.0127	-0.2614	-0.2046	-0.2905	-0.2782
								-0.0167	-0.5571**	-0.2198	-0.3419*	-0.3136
Protein content (%)									0.0701	-0.3774*	-0.2568	-0.2721
									0.1194	-0.3837*	-0.2705	-0.2783
Rate of germination (%)										0.2697	0.1137	0.1020
										0.4652**	0.1590	0.1424
100 grain weight (g)											0.5250**	0.5993**
											0.5450**	0.6165**
No. of grains per panicle												0.9683**
												1.0078**

Bold figures indicate genotypic correlation coefficients. * and ** = signficant at 5% and 1% level, respectively

genotypic level. Number of productive tillers plant^{-1} exhibited negative significant correlation with 100 grain weight at genotypic level. Number of productive tiller plant^{-1} exhibited negative significant correlation with 100 grain weight at both levels and with grain yield plant^{-1} at genotypic level. Similar results were reported by Murthy *et. al.* (1992).

Protein content exhibited significant positive correlation with RGR and significant negatie associationwith 100 grain weight. Similar results were reported by Hussein *et. al.* (1987). Rate of germination exhibited significant positive association with biomass production plant^{-1}, RGR and plant height at 15 days DAT to 60 DAT indicating that higher rate of germination produce more vigorous seedlings leading to accumulation of more biomass, increase in RGR and plant height. Hundred grain weight had significant positive association with biomass production plant^{-1}, plant height, rate of germination, number of grains panicle^{-1} and grain yield plant^{-1}. Similar results were obtained by Prasanth *et. al.* (1999) and Tarasatyavathi *et. al.* (2001). Higher biomass accumulation leads to efficient partitioning of photosynthates to the grain increasing the test weight and finally contributes to the higher yields. It is further observed that all the characters were associated among themselves and also with grain yield. In order to select high grain yield types, selection pressure has to be imposed on the biomass plant^{-1}, RGR, number of grains panicle^{-1}, 100 grain weight which had very positive correlation with grain yield.

Though the biomass plant^{-1} had negative direct effect on the grain yield plant^{-1} it exhibited positive correlation due indirect positive effects through rate of germination, number of productive tillers plant^{-1}, panicle length, number of grains panicle^{-1} and 100 grain weight. RGR had negative direct effect and negative correlation with grain yield plant^{-1} indicating that plants having optimum

Table 2: Direct and indirect effects of morphological and physiological characters on grain yield epr plant in rice.

	Biomass upto P-I	RGR upto P-I	Plant height upto P-I	Days to 50% flowering	Leaf N Boot leaf (%)	No. of productive tillers / plant	Panicle length (cm)	L/B ratio	Protein content (%)	Rate of germination (%)	100 grain wt. (g)	No. of grains / panicle
Biomass at 15 days interval upto P-I stage (g)	-0.0250	-0.0020	-0.0152	-0.0006	-0.0002	0.0053	-0.0031	0.0057	0.0032	-0.0076	-0.0087	-0.0049
	-0.1353	**-0.0108**	**-0.0831**	**-0.0033**	**0.0007**	**0.0294**	**-0.0250**	**0.0341**	**0.0176**	**-0.068**	**-0.0487**	**-0.0281**
RGR at 15 days interval upto P-I stage (g/g/day)	-0.0055	-0.0697	0.0043	-0.0017	-0.0122	-0.0060	-0.0067	-0.0070	-0.0302	-0.0310	0.0271	0.0090
	0.0022	**0.0271**	**-0.0017**	**0.0006**	**0.0053**	**0.0023**	**0.0043**	**0.0045**	**0.0126**	**0.0242**	**-0.0117**	**-0.0040**
Plant height at 15 days interval upto P-I stage	0.0320	-0.0032	0.0527	0.0002	0.0014	-0.0173	0.0232	0.0005	-0.0145	0.0135	0.0224	0.0127
	0.1501	**-0.0156**	**0.2443**	**0.0012**	**0.0080**	**-0.0833**	**0.1566**	**0.0019**	**-0.0678**	**-0.1040**	**0.1061**	**0.0622**
Days to 50% flowering	0.0015	0.0016	0.0003	0.0652	-0.0032	0.0106	0.0171	-0.0004	-0.019	-0.0197	-0.0182	-0.0130
	0.0050	**0.0047**	**0.0010**	**0.2016**	**-0.0116**	**0.0328**	**0.0744**	**-0.0011**	**-0.0493**	**-0.0975**	**-0.0574**	**-0.0423**
Leaf N boot leaf stage (%)	-0.0001	-0.0033	-0.0005	0.0009	-0.0188	-0.0006	0.0002	-0.0087	-0.0039	-0.0007	0.0061	0.0032
	-0.0001	**-0.0046**	**-0.0008**	**0.0014**	**-0.0238**	**-0.0007**	**0.0010**	**-0.0134**	**-0.0051**	**-0.0031**	**0.0082**	**0.0042**
No. of productive tillers per plant	0.0048	-0.0019	0.0075	-0.0037	-0.0007	-0.0228	-0.0006	-0.0035	-0.0039	0.0043	0.0131	0.0059
	-0.0293	**0.0116**	**-0.0459**	**0.0219**	**0.0041**	**0.1346**	**0.0138**	**0.0220**	**-0.0242**	**-0.0431**	**-0.0830**	**-0.0415**
Pancile length (cm)	0.0007	0.0005	0.0023	0.0014	-0.0001	0.0001	0.0053	0.0003	-0.0005	0.0003	0.0004	0.0006
	-0.0380	**-0.0327**	**-0.1321**	**-0.0761**	**0.0090**	**-0.0211**	**-0.2060**	**-0.0204**	**0.0286**	**-0.0326**	**-0.0291**	**-0.0434**
L/B ratio	-0.0066	0.0029	0.0003	-0.0002	0.0134	0.0045	0.0019	0.0290	-0.0004	-0.0076	-0.0059	-0.0084
	-0.0177	**0.0116**	**-0.0006**	**-0.0004**	**0.0397**	**0.0115**	**0.0069**	**0.0701**	**-0.0012**	**-0.0391**	**-0.0154**	**-0.0240**
Protein content (%)	-0.0088	0.0296	-0.0188	-0.0166	0.0140	0.0118	-0.0066	-0.0009	0.0683	0.0048	-0.0258	-0.0175
	-0.0167	**0.0595**	**-0.0356**	**-0.0314**	**0.0273**	**0.0230**	**-0.0178**	**-0.0021**	**0.1282**	**0.0153**	**-0.0492**	**-0.0347**
Rate of germination (%)	0.0042	0.0061	0.0035	-0.0041	0.0005	-0.0026	0.0007	-0.003	0.0010	0.0138	0.0037	0.0016
	0.0051	**0.0093**	**0.0044**	**-0.0050**	**0.0014**	**-0.0033**	**0.0017**	**-0.0058**	**0.0012**	**0.0104**	**0.0048**	**0.0017**
100 grain weight (g)	0.0343	-0.0382	0.0417	-0.0274	-0.0317	-0.0564	0.0081	-0.0201	-0.0370	0.0265	0.0982	0.0515
	0.0825	**-0.0990**	**0.0995**	**-0.0653**	**-0.0787**	**-0.01411**	**0.0324**	**-0.0504**	**-0.0879**	**0.1066**	**0.2291**	**0.1249**
No. of grains per panicle	0.1816	-0.1202	0.2231	-0.1846	-0.1583	-0.2384	0.1108	-0.2695	-0.2382	0.1055	0.4870	0.9276
	0.2145	**-0.1540**	**0.2632**	**-0.2168**	**-0.1808**	**-0.3186**	**0.2175**	**-0.3531**	**-0.2794**	**0.1642**	**0.5629**	**1.0329**
Grain yield per plant	0.2131	-0.1978	0.3012	-0.1711	-0.1959	-0.3118	0.1502	-0.2782	-0.2724	0.1020	0.5993**	0.9683**

Underlined values are direct effects and all other values are indirect effects. Figures in bold face are genotypic estimates.

RGR need to be selected. Plant height had positive direct effect on grain yield and its indirect effects through other characters were also cumulated to positive correlation with grain yield. Similar results were reported by Padmavathi *et. al.* (1996) and Shanti and Singh (2000). Leaf nitrogen in boot leaf had negative direct effect and negative correlation with the grain yield plant^{-1}. This clearly indicates excess nitrogenous fertilizer application even after panicle initiation stage will not help in higher grain yields and in contrary may reduce the grain yield.

Number of productive tillers showed negative direct effect on grain yield plant^{-1}. Simple selection of genotypes having optimum number of productive tillers is effective. Panicle length, number of grains panicle^{-1} and 100 grain weight had positive direct effect on grain yield plant^{-1}. Similar results were published by Shanti and Singh (23000) and Tarastyavathi (2001). The rate of germination and plant height at 15 days interval also showed positive direct effect on the grain yield. This result gives us scope of identifying potential genotypes early in crop growth period. Similarly protein content also had positive correlation with the grain yield. This indicates highly potential genotypes can be developed in rice with high protein content.

The present study indicates for developing high yielding potential rice genotypes selection pressure need to be imposed on rate of seed germination (seed vigour), plant height at regular intervals, panicle length, number of grains panicle^{-1} and 100 grain weight. Protein rich rices can also be developed, as there was positive direct effect of the same on grain yield.

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Hybrid Vigour of Quantitative and Qualitative Traits in Chilli (*Capsicum annuum* L.)

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ABSTRACT

Forty two F_1 hybrids involving seven female and six male parents were produced in chilli (*Capsium annuum* L.) in a line x tester design. Fourteen economic characters contributing to dry fruit yield were studied. Based on relative heterosis, heterobeltiosis and *per se* performance some crosses were identified for dry fruit yield per plant. The crosses V. local x LCA 315, G4 x Aparna, LCA 334 (E) x Pusa Jwala, G5 x LCA 333, LCA 334 (D) x LCA 357, LCA 353 x LCA 333, LCA 353 x LCA 424 and LCA 353 x LCA 357 manifested desirable heterosis for other characters also including dry pod yield per plant and these crosses are found to be promising.

Key words : Hybrid vigour, Chilli

Capsicum annuum L. is an important spice and vegetable crop grown for dry and green chilli. It is known for its flavour and pungency which are due to capsaicin. Many food industries have extracted the oleoresin from chilli which is being used in the preparation of processed products and pharamaceutical preparations. Of the various genetic approaches to break the yield barriers in chilli, heterosis breeding is most powerful one. Therefore, the present study to understand the extent and nature of heterosis in hybrids for various quantitative and qualitative traits in chilli.

MATERIAL AND METHODS

Seven female parents (G5, LCA 353, LCA 379, G4, LCA 334 (D), LCA 334 (E) V local) were crossed to six male parents (Aparna, LCA 424, LCA 357, Pusa Jwala LCA 315, LCA 333) in line x tester design and the F_1 seedlings along with their parents were planted in a randomized block design with three replications during 2004-05 at Regional Agricultural Research Station, Lam, Guntur. Each entry was planted in four rows with inter- and intra-row spacing of 75 x 75 cm. Five competitive plants from each entry were selected at random and data were recorded for days to 50% flowering, plant height, number of primary branches per plant, number of secondary branches per plant, plant spread, days to maturity, number of fruits per plant, fruit length, fruit girth, number of seeds per fruit, dry pod yield per plant, capsaicin, oleoresins and capasanthin. Heterosis over mid parent and better parent were worked out as per the standard procedure given by Turner (1953) and Hayes *et. al.* (1955).

RESULTS AND DISCUSSION

The estimates of mean squares due to genotypes for all the characters studied were highly significant indicating the wealth of genetic variability among the lines, testers and crosses created by hybridization. The characters taken for study showed significant amount of heterosis in desirable direction. The range of heterosis and number of crosses showing heterosis over mid parent and better parent for fourteen traits have been presented in Table.

In the present study corsses with high *per se* performance also exhibited significant heterosis for most of the characters. This direct relationship was a suitable index to determine the performance of crosses for exploitation of heterosis. The F_1 hybrid with highest mid parent and better aprent heterosis were G5 x Aparna (76.54%) and G5 x Pusa Jwala for plant height, LCA 334 (E) x Pusa Jwala (71.74 and 64.58%) for number of primary branches per plant, V. local x LCA 315 (85.57 and 82.19%) for secondary branches per plant, G5 x LCA 357 (189.43 and 161.47%) for plant spread. These results are in consonance with findings of Patel *et. al.* (2003) and Gouda *et. al.* (2003). For days to 50% flowering significant negative heterosis to an extent of –21.79 and –22.68 per cent over mid aprent and better parent respectively,was found in the crosses LCA 334 (D) x LCA 315 and LCA 353 x Aparna, while same was observed upto tune of –7.10 and –

Table: Per cent heterosis over mid parent (MP) and better parent (BP) for 18 characters in chilli (*Capsicum annuum* L.)

S.No.	Crosses	Days to 50% flowering Heterosis over		Plant height Heterosis over		No. of primary branches / plant Heterosis over		No. of secondary branches / plant Heterosis over		Plant spread Heterosis over		Days to fruit ripending Heterosis over		No. of seeds per fruit Heterosis over	
		MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
1	G5x Aparna	-19.35**	-22.63	76.54**	53.85**	-45.68**	-51.11**	27.33**	21.91**	149.4**	135.2**	-6.72**	-10.76**	16.54**	-5.93
2	G5xLCA 424	12.78**	-15.74**	33.13**	16.64**	-25.86**	-40.28**	23.95**	2.89	45.51**	5.47**	-0.88	-2.59*	32.90**	7.21
3	G5xLCA 357	-7.32	-9.79**	34.60**	10.71**	-27.27**	-33.33**	36.66**	15.49**	89.00**	46.2**	-3.55**	-4.76**	141.03**	103.81**
4	G5 x Pusa Jwala	-7.30**	-8.09**	72.06**	63.14**	45.00**	20.83**	57.80**	35.79**	189.4**	161.5**	2.61**	1.72	100.60**	75.74**
5	G5 x LCA 315	-13.39**	-14.81**	50.69**	40.33**	-26.09**	-29.17**	37.70**	28.65**	67.05**	23.2**	-2.95**	-4.96**	86.86**	53.60**
6	G5 x LCA 333	-7.49**	-10.64**	31.69**	5.57**	-5.98**	-23.61**	14.72**	-1.82	59.78**	12.81**	1.44	1.44	57.40**	52.33**
7	LCA 353 x Aparna	-3.48**	-13.28**	26.50**	20.28**	-23.49**	-36.67**	18.16**	-0.68	58.69**	5.02**	-2.54**	-9.45**	166.46**	146.20**
8	LCA 353 x LCA 424	0.71	-2.74**	25.86**	18.96**	22.33**	6.78**	20.61**	17.31**	20.55**	9.23**	7.69**	6.25**	65.158**	19.30**
9	LCA 353 x LCA 357	1.41	-2.70*	10.68**	8.62*	21.01**	20.00**	18.42**	12.76**	30.00**	8.33**	0.00	-4.20**	135.69**	130.26**
10	LCA 353 x Pusa jwala	-6.21**	-11.69**	26.27**	10.32**	21.50**	10.17**	12.58**	5.01	52.51**	10.77**	-1.35	-3.41**	129.27**	125.07**
11	LCA 353 x LCA 315	-10.07**	-17.28**	15.69**	2.77	-20.80**	-25.00	1.92	-21.41**	9.43**	-3.26*	-1.74	-6.61**	94.24**	83.45**
12	LCA 353 x LCA 333	0.71	-2.74	8.92**	3.51	21.15**	6.78**	7.28*	0.68	15.00**	8.47**	2.81**	-0.29	33.03**	11.60*
13	LCA 379 x Aparna	-16.10**	-22.68**	0.23	-6.28	-57.68**	-65.56**	21.88**	14.37**	34.19**	-9.49**	-0.41	-5.51**	142.54**	134.89**
14	LCA 379 x LCA 424	-5.29**	-5.94**	5.69	-1.74	43.28**	27.43**	26.98**	15.66**	8.60**	1.84	-0.88	-1.75	60.24**	12.35**
15	LCA 379 x LCA 357	-4.11**	-5.14**	12.74**	12.61**	-21.03**	-23.33**	5.42	-2.02	19.44**	2.64	-3.86**	-5.88**	90.80**	85.90**
16	LCA 379 x Pusa jwala	-9.17**	-12.12**	23.71**	6.47	-6.22**	-17.27**	12.62**	6.84	41.23**	5.08**	1.17	1.17	127.99**	113.38**
17	LCA 379 x LCA 315	-11.11**	-16.05**	22.95**	7.56*	-22.45**	-28.03**	79.27**	52.20**	2.85	-5.99**	-0.43	-3.31**	121.68**	119.71**
18	LCA 379 x x LCA 333	-3.91**	-4.57**	25.43**	21.23**	12.32**	0.88	38.02**	30.13**	9.00**	6.59**	0.29	-0.57	53.32**	23.69**
19	G4x Aparna	-14.63**	17.98**	40.31**	31.63**	-5.26**	-25.00**	24.29**	10.37	125.6**	73.92**	-4.80**	-6.30**	124.25**	112.87**
20	G4xLCA 424	-3.74**	-7.20**	18.12**	11.46**	-29.53**	-35.24**	18.39**	-7.71	23.74**	7.38**	-0.43	-4.58**	27.72**	-9.36*
21	G4xLCA 357	-10.92**	-13.56**	15.70**	1.86	-11.11**	-16.67**	40.86**	11.59**	46.65**	39.03**	-5.79**	-7.32**	116.95**	115.79**
22	G4 x Pusa Jwala	-8.78**	-9.75**	48.83**	44.43	55.22**	48.57**	70.92**	37.63**	121.8**	95.00**	-2.95**	-6.50**	127.07**	116.76**
23	G4 x LCA 315	-16.08**	-17.28**	29.45**	28.37	-32.49**	-39.30**	60.85**	58.82**	42.30**	26.48**	-4.10**	-4.88**	105.82**	99.85**
24	G4 x LCA 333	-5.05**	-8.47**	28.91**	10.31**	-12.82**	-19.05**	28.36**	2.86	25.09**	4.69*	0.42	-2.44*	45.66**	19.43**
25	KCA 334 (D) x Aparna	-16.27**	-17.58**	10.21**	-2.18	-28.33**	-52.22**	42.72**	41.31**	71.68**	19.08**	-7.05**	-9.97**	57.09**	24.63**
26	KCA 334 (D)xLCA 424	-15.20**	-20.16**	-4.52	15.71**	14.86**	-3.44	23.06**	6.75	16.36**	14.71**	-1.88	-4.76**	-8.61	-24.95**
27	KCA 334 (D)xLCA 357	-9.36**	-14.11**	16.27**	10.05**	55.56**	16.67**	34.47**	18.89**	50.48**	35.26**	-0.84	-0.84	64.66**	36.67**
28	KCA 334 (D) x Pusa Jwala	13.57**	-16.53**	10.66**	-9.12**	47.44**	19.79**	33.43**	20.26**	64.99**	27.17**	-3.00**	-5.04**	32.23**	13.61**
29	KCA 334 (D) x LCA 315	-21.79**	-22.58**	-2.65	-18.82**	-21.88**	-13.18**	33.70**	19.02**	3.31	-0.87	-1.67	-2.48*	50.08**	21.19**
30	KCA 334 (D) x LCA 333	-11.35**	-16.53**	-0.48	-2.73	10.67**	-7.78	11.59**	0.00	-7.88**	-10.52**	4.68**	3.36**	-32.32**	-33.00**
31	KCA 334 (E) x Aparna	-13.22**	-17.97**	-5.62*	-19.50**	-28.36**	-46.67**	39.83**	44.82**	46.57**	-0.24*	-4.53**	-8.66**	103.75	56.97**
32	KCA 334 (E)xLCA 424	-8.72**	-10.93**	2.80	-12.77**	46.59**	46.59**	44.38**	20.72**	25.90**	20.00**	-1.75	-3.45**	4.67	-11.18**
33	KCA 334 (E)xLCA 357	-7.11**	-8.33**	4.54	- 5.22	6.73**	-7.50	14.79**	-2.27	24.97**	8.97**	-2.13*	-3.36**	65.98**	33.46**
34	KCA 334 (E) x Pusa Jwala	-1.96**	-2.60**	28.39**	1.76	71.74**	64.58**	66.31**	44.21**	64.61**	23.88**	2.61**	1.72	22.15**	1.49
35	KCA 334 (E) x LCA 315	-9.55**	-12.35**	8.60**	-12.67**	1.82	-15.15**	60.15**	48.39**	23.22**	14.42**	-2.11*	-4.13**	96.07**	53.59**
36	KCA 334 (E) x LCA 333	-1.70**	-6.58**	-4.59	10.82**	21.35**	20.00**	6.33	-8.39	12.22**	11.62**	-1.72	-1.72	-9.41	-12.12*
37	V. local x Aparna	-11.69**	-14.45**	13.13**	0.87	-33.79**	-46.67**	45.32**	31.77**	70.57**	28.09**	-2.01*	-3.94**	46.86**	11.29*
38	V. localxLCA 424	-11.11**	-15.00**	16.55**	3.35	47.47**	32.73**	46.33**	17.11**	43.53**	28.73**	-2.56**	-6.54**	4.50	-9.55*
39	V. localxLCA 357	-5.19**	-8.75**	18.45**	12.67**	-14.78**	-18.33**	41.61**	14.86**	36.70**	34.47**	-2.07**	-3.28**	29.73**	2.49
40	V. local x Pusa Jwala	-4.46**	-6.25**	48.89**	22.78**	14.56**	7.27	65.55**	26.58**	97.32**	67.91**	-4.24**	-7.38**	19.02**	-2.93
41	V. local x LCA 315	15.53**	-16.05**	20.00**	0.49	-9.09**	-16.67**	85.57**	82.19**	50.97**	38.87**	-7.00**	-7.38**	70.46**	31.29**
42	V. local x LCA 333	-2.19**	-11.25**	4.78	2.93	4.00	-5.45*	1.96	8.31	28.83**	11.28**	-2.52**	-4.92**	-13.31**	-17.78**
	SE±	0.692	0.799	2.6464	2.846	0.084	0.097	0.979	1.130	1.957	2.260	1.117	1.289	3.308	3.820
	CD 1 at 1%	1.825	2.108	6.499	7.504	0.221	0.255	2.581	2.980	5.260	5.959	2.945	3.401	8.724	10.073

Contd..

S.No.	Crosses	No. of fruits per plant Heterosis over		Fruit length Heterosis over		Fruit girth Heterosis over		Capsaicin (%) Heterosis over		Oleoresins (%) Heterosis over		Capsanthin (EOA values) Heterosis over		Dry pod yield per plant Heterosis over	
		MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
1	G5x Aparna	31.28**	0.26	54.19**	28.83**	5.31	-17.90**	53.15.**	31.14**	47.58**	43.50**	84.44**	32.62**	43.90**	18.00
2	G5xLCA 424	56.81**	23.14**	-4.83	-36.48**	43.05**	-3.03	9.09**	-9.24**	16.99**	6.95**	34.43**	3.59	10.34	-23.81**
3	G5xLCA 357	82.79**	45.31**	31.12**	1.42	94.80**	52.96**	34.69**	13.14**	17.31**	15.93**	29.77**	3.77	50.00**	8.33
4	G5 x Pusa Jwala	198.7**	159.2**	14.42**	-18.60**	156.8**	121.8**	38.10**	16.00**	26.26**	14.84**	29.69**	20.60**	86.21**	28.57**
5	G5 x LCA 315	113.1**	98.52**	9.88**	20.20**	46.12**	13.90**	36.76**	21.57**	28.83**	22.78**	2.90	-2.96	111.27**	92.31**
6	G5 x LCA 333	90.69**	47.14**	27.78**	-3.88	60.85**	26.61**	48.46**	36.88**	10.04**	2.54	-12.38**	-16.64**	102.90**	65.35**
7	LCA 353 x Aparna	65.35**	54.73**	37.54**	24.28**	9.44	-2.29	40.52**	28.74**	34.83**	34.58**	3.85	-34.82**	37.70**	16.67*
8	LCA 353 x LCA 424	5.99**	-4.23	17.88**	-4.61*	15.23**	-13.58**	-15.60**	-33.81**	-0.53	-11.20**	12.95**	8.93**	25.64**	16.67*
9	LCA 353 x LCA 357	82.37**	62.24**	35.01**	34.36**	25.57**	13.12*	20.38**	8.00**	23.49**	21.70**	14.93**	13.32**	25.00**	25.00**
10	LCA 353 x Pusa jwala	106.0**	67.43**	7.18**	-4.58	64.22**	24.61**	52.87**	37.14**	29.50**	20.69**	8.15**	-9.28**	24.36**	15.48*
11	LCA 353 x LCA 315	137.7**	82.16**	22.06**	12.01**	14.35**	2.10	38.36**	32.03**	8.46**	6.06**	-4.73	-27.77**	40.54**	8.33
12	LCA 353 x LCA 333	56.21**	42.86**	33.98**	29.39**	14.56**	3.52	30.71**	29.79**	2.53	-2.04	28.07**	5.36**	57.98**	34.72**
13	LCA 379 x Aparna	26.85**	18.22**	40.03**	29.72**	55.53**	35.24**	42.37**	25.75**	12.25**	10.83**	37.62**	5.61**	-17.24	-27.27**
14	LCA 379 x LCA 424	48.81**	33.94**	9.74**	-13.01**	14.59**	-15.76**	14.98**	-31.25**	42.07**	28.07**	-14.70**	-38.45**	41.33**	26.19**
15	LCA 379 x LCA 357	66.49**	47.55**	37.01**	33.98**	45.04**	27.21**	4.29**	-9.71**	23.49**	23.04**	77.47**	32.50**	26.09**	20.83*
16	LCA 379 x Pusa jwala	150.1**	102.6**	7.55**	-6.50*	59.60**	23.71**	38.61**	20.00**	7.79**	-0.56	41.57**	20.63**	8.00	-3.57
17	LCA 379 x LCA 315	19.88**	-8.41	20.11**	7.54*	42.83**	24.19**	-13.88**	-20.92**	39.58**	35.04**	22.71**	18.07**	14.29	-9.09
18	LCA 379 x x LCA 333	63.45**	49.94**	25.47**	18.04**	28.81**	13.31*	7.06**	2.13	12.60**	6.47**	28.79**	12.02**	23.29*	9.09
19	G4x Aparna	173.9**	107.3**	76.99**	44.95**	21.77**	8.95	30.10**	12.57**	37.84**	35.21**	15.72**	-18.32**	149.41**	110.00**
20	G4xLCA 424	19.55**	-7.10	16.77**	-13.28**	14.89**	-13.70**	0.50	-17.21**	4.32	-8.18**	35.50**	6.76	11.68	-21.43**
21	G4xLCA 357	124.0*	76.30**	39.92**	25.40**	32.19**	19.34**	35.35**	14.83**	8.63**	4.86	25.43**	2.71	41.21**	4.17
22	G4 x Pusa Jwala	328.7**	267.7**	10.46**	10.94**	74.20**	31.97**	41.41**	20.00**	29.94**	23.54**	26.93**	21.51**	79.36**	26.19**
23	G4 x LCA 315	103.6**	87.30**	34.07**	10.98**	30.92**	17.14**	24.36**	11.76**	23.61**	23.44**	19.06**	9.11**	63.93**	53.58**
24	G4 x LCA 333	88.90**	44.70**	42.51**	23.35**	15.83**	4.89	-5.70**	-12.06**	-6.64**	-8.95**	-0.55	-2.51	60.00**	33.86**
25	KCA 334 (D) x Aparna	80.08**	63.98**	33.70**	28.11**	13.65**	7.17	17.92**	8.38**	0.24	-5.81**	9.19**	-23.70**	58.20**	54.58**
26	KCA 334 (D)xLCA 424	2.38	-9.89	-3.16	-25.20**	-6.31	-19.52**	0.46	-21.43**	2.67	-13.33**	37.70**	9.91**	14.37	-7.14
27	KCA 334 (D)xLCA 357	87.83**	62.86**	32.37**	25.04**	-8.76*	-14.77**	26.32**	13.71**	27.86**	18.32	26.58**	5.10**	68.81**	45.83**
28	KCA 334 (D) x Pusa Jwala	180.9**	123.2**	14.43**	-3.45	28.29**	-12.74**	35.87**	22.29**	19.18**	18.34**	17.55**	14.45**	31.96**	7.44
29	KCA 334 (D) x LCA 315	17.56**	-11.73**	19.80**	3.99	45.68**	37.38**	18.77**	13.73**	5.82	1.43	-22.73**	-30.29**	40.04**	22.14*
30	KCA 334 (D) x LCA 333	13.58**	1.84	19.60**	8.86**	42.64**	32.83**	6.76**	6.38**	-4.34	-6.16**	36.64**	36.29**	4.65	3.05
31	KCA 334 (E) x Aparna	55.37**	34.25**	41.75**	27.58**	12.58**	8.69	30.35**	22.16**	22.22**	12.87**	-9.14**	-37.45**	31.39**	20.81*
32	KCA 334 (E)xLCA 424	18.72**	-0.62	10.81**	-10.03**	9.58*	-77.76*	6.67**	-17.81**	22.40**	1.177	33.93**	9.06**	33.70**	14.29*
33	KCA 334 (E)xLCA 357	25.09**	3.26	34.68**	33.45**	24.62**	19.15**	34.58**	23.43**	8.81**	-1.01	26.48**	7.27**	23.10**	12.50
34	KCA 334 (E) x Pusa Jwala	167.1**	103.3**	1.15	-9.61**	24.50**	-14.18**	51.40**	38.86**	16.44**	15.11**	21.93**	21.85**	106.13**	76.19**
35	KCA 334 (E) x LCA 315	92.44**	39.03**	26.74**	16.76**	11.66**	7.80	78.60**	74.51**	17.83**	10.95**	20.79**	6.47**	76.47**	45.97**
36	KCA 334 (E) x LCA 333	73.63**	47.87**	25.17**	21.39**	-1.21	-5.85	34.49**	32.19**	19.05**	14.68**	24.89**	21.99**	52.17**	40.94**
37	V. local x Aparna	103.4**	78.20**	35.55**	13.47**	-3.47	-7.24	48.15**	19.76**	23.10**	21.88**	0.36	-33.51**	28.76*	20.00*
38	V. localxLCA 424	44.89**	31.26**	6.51**	-7.32**	-0.08	-20.73**	-29.67**	-37.86**	31.48**	18.23**	38.17**	19.45**	41.51**	7.14
39	V. localxLCA 357	157.6**	137.1**	23.80**	13.10**	4.16	1.07	-4.32**	-24.00**	9.29**	8.58**	34.18**	21.27**	19.79*	-4.17
40	V. local x Pusa Jwala	173.7**	67.57**	-9.48**	-12.45**	39.07**	0.21	44.60**	14.86**	16.11**	7.39**	12.24**	4.58*	60.38**	21.43**
41	V. local x LCA 315	78.52**	61.81**	11.49**	11.49**	34.39**	29.14**	41.41**	18.30**	-4.19	-7.06**	1.25	-16.07**	126.28**	115.28**
42	V. local x LCA 333	106.1**	83.29**	17.17**	11.13**	9.75*	6.85	39.34**	20.57**	11.75**	5.94**	21.36**	10.57**	78.72**	65.35**
	SE±	7.497	8.656	0.234	0.269	0.156	0.180	0.007	0.008	0.052	0.061	119.54	138.04	8.606	9.938
	CD 1 at 1%	19.768	22.826	0.616	0.711	0.411	0.474	0.018	0.021	0.139	0.160	315.26	364.03	22.696	28.207

* Significant at 5% level, ** Significant at 1% level.

10.76 per cent in the same crosses for days to fruit ripening. Geleta and Labuschagne (2004) and Gandhi *et. al.* (2000) also reported significant heterosis for these two characters.

Heterosis up to 267.69 per cent for number of fruits per plant and 146.26 per cent for number of seeds per fruit were manifested in the crosses G5 x Pusa Jwala and LCA 353 x Aparna respectively. Similar high levels of heterosis were earlier reported by Patel *et. al.* (2004). The crosses LCA 334 (E) x LCA 315 and G5 x Aparna recorded significant heterosis over both mid and better parent for the characters capsaicin an oleoresin. Dry pod yield per plant exhibited highest significant positive heterosis over mid parent (126.28%) and better parent (115.28%) in the cross V. local x LCA 315, succeeded by G4 x Aparna (149.41 and 110.00%) and followed by LCA 334 (E) x Pusa Jwala, G5 x LCA 333, LCA 334 (D) x LCA 357, LCA 353 x LCA 333, LCA 353 x LCA 424 and LCA 353 x LCA 357. Heterosis to the extent of more than 100 per cent for this character has been reported earlier by Geleta and Labuschagne (2004) and Patel *et. al.* (2004). Further these crosses exhibited significant positive heterosis over mid parent and better parent for the other traits. LCA 334 (D) x LCA 357 and V. local x LCA 357 showed significant positive heterosis for 10 characters, G4 x Aparna and LCA 334 (D) X Aparna for six character each, LCA 334 (E) x Pusa Jwala for five characters and G5 x LCA 333 for eight characters. Hence, the present study suggests that heterosis for fruit yield is through component heterosis. Hybrid vigour of even small magnitude for individual yield component may have additive or synergistic effect on the end product. These findings corroborated with the study of Patel *et. al.* (2004).

In the present study plant spread and number of fruits per plant contributed largely to the fresh fruit and dry pod yield per plant and also high heterosis for fruit yield is attributed to indeterminate growth habit of the hybrids with higher order of branching, more flowering nodes and plant spread. Manifestation of relative heterosis in F_1 hybrids indicated the presence of dominance for these characters. Where as heterobeltiosis revealed considerable over-dominance for all the characters. Negative heterosis observed in some of the crosses over all the characters may be attributed to non-allelic interaction which can either increase or decrease the expression of heterosis.

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Journal
Since 1954

In-Vitro Performance of Two Prominent Sugarcane (*Saccharum officinarum* L.) Varieties

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ABSTRACT

An efficient and direct shoot multiple induction from apical meristems of two prominent sugarcane varieties Co86032 and CoM 88121 was tried. The carefull excised apical meristems of 0.1 mm diameter and and 2.5 mm length cultured on MS Medium augmented with 1 mg/l/BAP and 0.1 mg/l NAA under aseptic condition showed fast initiation within 48 to 52 days for Co86032 and CoM-88121, respectively. MS medium along with 2 mg/l BAP and 0.1 mg/l NAA produced maximum shooting within 36 to 38 days in both the varieties. After profuse shooting obtained among them heightened plantlets were carried over for rooting. The root initiation was achieved by MS medium augmented wih 1 mg/l IBA and 3 mg/l NAA. The period required for rooting in two varieties was different. Variety CoM 88121 took 22 days as against 30 days for Co 86032. the total period required for hardening and ready to field planting was 210 days for Co 86032 and 201 days for CoM 88121.

Key words : *In-Vitro*, Sugarcane, Apical Meristem

The conventional method of propagation through stem cuttings in sugarcane shows some limitations as it takes longer time for multiplication. Similarly the risk of pests and diseases carry over is also encountered.

Sugarcane tissue culture (through micro-propagation) offers the best methodology to obtain quality seeds at a faster rate within a shorter period of time (Sreenivasan and Sreenivasan, 1992). Further, this technique was also found to be useful to avoid the dissemination of diseases and pests which occurs during transport of seed material of popular variety from one state to other. The usefulness of the system for seed renovation, germplasm storage and exchange has been well documented by Sreenivasan and Jalja (1987). The present study attempts to standardize in-vitro technique of two sugarcane varieties Co 86032 and CoM 88121 for growth response, days required for shooting, rooting and hardening.

MATERIAL AND METHODS

Higher plants which bear seeds grow through the activity of their apical meristems. The apical meristem or growing region is composed of a mass of small cells situated at the extreme tip of the shoot or root in a shape like dome. The actively growing shoots of 3 to 4 month age sugarcane variety Co 86032 and CoM 88121 were collected from the germplasm of Sugarcane Breeding Section, Central Sugarcane Research Station, Padegaon. The tops with growing apex were cut, the tops were first washed with running tap water and outer sheaths removed by wiping with rectified spirit. The shoots were then washed with soap and detergent water for about 3 to 4 min followed by through washing under running tap water for 30 min. The shoots were then thoroughly rinsed with 70% ethanol for 1 min and washed 4 to 5 times with distilled sterile water. The shoots were then surface sterilized with an aqueous solution of 0.1% (w/v/) Hg Cl_2 (HiMedia, India) for 2-3 minute followed by a final 5-6 rinses with sterile water and then taken to a clean laminar flow station.

The isolation of meristems of Co 86032 and CoM 88121 was done carefully by removing the outer whorls of developing leaves for exposing apical dome (procambium). The shoot meristem measure approximately 0.1 mm in diameter and 2-5 mm length for Co 86032 and 2.6 mm for CoM 88121. The isolated meristems were then inoculated in the medium which was based on Murashige and Skoog and White's medium (1943) contained modified concentration of 6 furturyl benzylaminopurine (BAP), naphthalene acetic acid (NAA) and indol buetyric acid (IBA). All the cultures were maintained at 23 ± 2 °C under 16 hours light of 5500 to 6000 lux and 65% relative humidity. Periodical observations were recorded by taking average of three readings for days required for initiation, shooting, rooting and hardening of plantlets.

RESULTS AND DISCUSSION

Apical meristem growth and sprouting

In both the varieties the primary growth of meristem and sprouting was found to be

Table 1: In vitro performance of two sugarcane cultivars Co-86032 and CoM-88121.

Variety	Size of meristem		Days required for initiation of meristem	Browing of media	Days required for shooting	Days required for rooting	Hardening of planlets		Total age of plantlets (days)
	Diameter (mm)	Length (mm)					Under poly-house	Outside poly-house	
Co 86032	0.1	2.5	52	Abundant	38	30	40	50	210
CoM 88121	0.1	2.6	48	less	36	22	45	50	210

*Observations were recorded on the basis of average of three readings.

satisfactory (Table 1). After inoculation of meristems of both the varieties in MS-medium supplemented with 1 mg/*l* BAP and 0.1 mg/*l* NAA initially it grows very slowly. The results presented in Table 1 indicated that browning of media due to the polyphenols exudation was seen to be abundant in Co 86032 variety as compared to CoM 88121. The variety Co 86032 required four transfers at an interval of 15 days as against three transfers for CoM 88121. Among the varieties, Co 86032 has taken more days (52 days) for initiation of meristem or to complete the primary growth of meristems whereas 48 days were required for CoM 88121.. After completion of primary growth of meristem the same were inoculated to MS-medium augmented with 2 mg/*l* BAP and 0.1 mg/*l* NAA, for getting sprouting and the level of hormones was found to be optimum. After 34-40 days new shoots were found to arose from the axils of the developing shoots. The developing shoots were then separated and repeated for every 30-40 days for multiplication. The rate of period of multiplication of both the varieties is given in Table 2.

Table 2: In vitro multiplication rate of sugarcane.

Shoot tip No.	No. of shoots	Ratio	No. of days in each cycle	Total days taken
1	1	-	15	15
1	1	-	21	36
1	1	-	21	57
1	6	1:6	45	102
6	36	1:6	45	147
36	216	1:6	45	192
216	2160	1:10	45	237
2160	21600	1:10	45	282
21600	216000	1:10	45	327
Rooting	200000		45	372
Nursery	180000			
Area covered	10 ha			

Rooting and hardening of plantlets

The data on days required for rooting, hardening and total age of plantlets as varied by the two varieties is presented in Table 1. The branch after profuse shooting was then inoculated to the rooting liquid MS medium augmented with 1 mg/l and 2 mg/l NAA. During rooting stage among the profuse shoots the tall plantlets rooted early than dwarf. Co 86032 rooted in 30 days and the CoM 88121 rooted within 22 days. The differences in period required for rooting of two varieties could possibly either due to differential responses of cells to various hormonal balance or other inherent or physiological reasons.

The hardening stage of rooted plantlets of both the varieties were studied under controlled polyhouse condition. After profuse root system developed, the plantlets were washed thoroughly with water and planted in polybags of 10 cm x 5.5 cm size filled with the mixture of sieved sand, silt and decomposed compost in 1:1:1 ratio and irrigated before planting. The plantlets were then kept under polyhouse where the temperature was maintained at 29±2°C and humidity at 80±2 per cent with the help of foggers and shading net. More or less similar period was required for hardening of the plantlets for both the varieties. However, the total age up to field planting varied. The Co 86032 attended the age of 210 days while CoM 88121 was 201 days. Similar results were obtained by Sreenivasan and Sreenivasan (1992), Zunjarrao and Gunjal (2000), Shukla *et. al.* (1994).

The sugarcane varieties Co 86032 and CoM 88121 responded well to the various hormonal levels under controlled *in-vitro* condition. 1 mg/l BAP and 0.1 mg/l NAA was noticed to be suitable hormonal level for primary initiation of apical meristem, 2 mg/l BAP and 0.1 mg/l NAA for shooting and 1 mg/l IBA and 3 mg/l NAA for rooting. Between the two varieties CoM 88121 has taken 201 days while Co 86032 required 210 days for *in-vitro* to filed planting establishment.

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Journal
Since 1954

Line x Tester Analysis for Combining Ability in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Fifteen crosses were affected with 5 lines and 3 testers in line x tester mating design during *kharif*, 2002 and these were studied with parental lines for their combining ability in randomized complete block design with three replications at Agricultural Farm, Bapatla during *rabi*, 2002-03. Predominance of non-additive gene action was recorded for nine important yield attributes including pod yield per plant. Both additive and non-additive gene action were found to be important for five metric traits. Additive type of gene action was governing the inheritance of character shelling percentage. The cultivar, Kadiri-4 was adjudged to be the best general combiner for pod yield as well as harvest index. The varieties Narayani, Tirupati-4 and Kalahsti were also found to be the good general combiners for six, four and three metric traits, respectively. The cross combinations of the parental liens *i.e.*, Kadiri-4, Narayani, Tirupati-4 and Kalahasti are likely to throw transgresants for most of the yield attributes as the parents possessed high gca effects which amounted to additive and additive x additive type of gene action which is exploitable and fixable in nature in the segregating progenies.

Key words : General Combining Ability, Specific Combining Ability, Additive Gene Action, Non-additive Gene Action

Groundnut (*Arachis hypogaea* L.) is the most important oil seed crop and a food legume in India. Groundnut breeding programmes have been directing more emphasis towards hybridization followed by selection for increasing yield. Information on the gene action governing the yield and its components in groundnut is essential for identifying the potentially useful parents and useful cross combinations that could yield superior segregants. Line and tester analysis is a simple and powerful tool for pinpointing the correct parents based on combining ability estimates. The knowledge on the relative importance of GCA and SCA variances is quite useful for understanding the relative components for the expression of a particular trait which is expressed as $2\sigma^2$ GCA / $2\sigma^2$ GCA + σ^2 SCA ratio (Becker, 1975). Therefore, a study was undertaken to evaluate the genetic potential of certain released cultivars of groundnut for important economic traits.

MATERIAL AND METHODS

The experimental material comprised twenty three genotypes of which five were liens (Vemana, Kadiri-4, Tirupati-1, Tirupati-4 and JL-24), three were testers (Tirupati-3, Narayani and Kalahasti) and fifteen F's derived out of a line x tester mating system. The crosses were effected during *kharif*, 2002 and the experiment was conducted in a randomized block design with three replications at Agricultural College Farm, Bapatla during *rabi* 2002-03. Each treatment was sown in two rows of 3 m length by adopting inter- and intra-row spacing of 30 cm x 15 cm. Observations were recorded on five competitive plants selected at random and plot basis for yield and yield attributes. F'_1s were identified through distinctive dominant morphological traits (red testa colour), habit group and vigour of the F'_1s as compared to their parental lines. The data were subjected to combining ability analysis for different characters using the line x tester model as given by Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences between genotypes for all the characters. The analysis of variance for combining ability analysis under line x tester analysis (Table 1) indicated that crosses, parents, lines and line x tester interactions were found to be highly significant for most of the traits. The analysis revealed significant differences among lines for days to 50 per cent flowering, days to maturity, total dry matter per plant, harvest index, 100 pod weight, shelling per cent and 100 kernel weight. Among testers, significant differences were observed for days to 50 per cent flowering, days to maturity, number of primary branches, number of secondary branches, shelling per cent and 100 kernel weight. Among hybrids, significant differences were observed for majority of the characters except for days to 50 per cent flowering, number of primary branches and shelling per cent.

Table 1: Analysis of variance for line x tester mating design for combining abililty in groundnut

Source of varia-tion	df	Days to 50% Flowering	Days to matu-rity	Height of the main axis	~~No. of~~ pri-mary bran-ches		No. of mature pods	No. of imma-ture pods	TDMP	H.I	SMX	100 pod weight	Shelling %	100 kernel wt.	Oil con-tent	Pod yield / plant
Lines	4	13.25**	49.42**	16.66	0.270	1.11	18.07	0.908	232.31**	31.63**	8.77	148.79**	8.50**	71.50**	5.96	13.59
Testers	2	12.28**	174.20**	3.28	1.470**	3.65**	1.14	0.600	20.85	4.79	23.80	2.94	25.31**	49.53**	2.29	0.12
Lines x Testers	8	1.87	6.33*	10.44**	0.130	0.84	16.69**	0.650**	47.03**	6.88**	13.50**	6.82**	0.79	3.86**	13.62**	7.73**
Error																
GCA	44	1.24	2.20	2.03	0.080	0.03	0.29	0.074	1.24	0.89	0.81	0.31	0.73	0.48	1.77	1.14
SCA		0.16	1.28	0.02	0.008	0.01	0.06	0.002	1.73	0.23	1.30	1.41	0.20	0.91	0.13	0.54
$2\sigma^2$ GCA / $2\sigma^2$		0.21	1.37	2.08	0.016	0.26	5.46	0.191	15.26	1.99	4.23	2.17	0.02	1.12	3.94	2.19
GCA + σ^2 SCA		0.60	0.65	0.01	0.500	0.07	0.02	0.020	0.18	0.18	0.38	0.56	0.95	0.61	0.06	0.33

* = Significant at 5% level, ** = Significant at 1% level

Proportional contributions due to crosses was found to be more than the lines or testers for the traits *viz.,* sound mature kernel and oil percentage which is suggestive of higher values of SCA and hence predominance of non-additive gene action. The proportional contributions of lines were higher for most of the characters including pod yield. Higher contribution of lines indicated high GCA and predominance of additive gene action.

The estimates of variance components (GCA and SCA) revealed that the SCA variances were higher than the GCA variance components for all the characters except for shelling percentage indicating the predominance of non-additive gene action. However, the role of both additive and non-additive gene action was evident from $2\sigma^2$ GCA / $2\sigma^2$ GCA + σ^2 SCA ratio being intermediate for characters *viz.,* days to 50 per cent flowering, days to maturity, number of primary branches, 100 pod weight and 100 kernel weight. Vijayabahaskar Reddy *et. al.* (1986) also reported both additive as well non-additive gene action for days to 50 per cent flowering, 100 pod weight and 100 kernel weight. Non-additive gene action was predominant for height of the main axis, number of secondary branches, number of mature pods, number of immature pods, total dry matter per plant, harvest index, sound mature kernel, oil content and pod yield per plant. Kalaimani and Thangavelu (1996) for total dry matter per plant, harvest index, number of secondary branches and pod yield per plant, Vindhiyavarman (2000) for number of mature pods and Jayalakshmi *et. al.* (2002) for sound mature kernel percentage also reported non-additive gene action. These observations suggest that in groundnut breeding, the methodology that can exploit both additive as well as non-additive effects would be of immense value.

The estimates of GCA effects (Table 2) revealed that Kadiri 4 was adjudged to be the best general combiner for pod yield per plant and harvest index. Narayani is the next best parent, which possessed high *per se* and GCA effects for as many as six important yield attributes *i.e.,* days to maturity, number of immature pods, number of mature pods, 100 pod weight, shelling percentage and 100 kernel weight. Tirupati-4 was found to be good general combiner for four important yield components *viz.,* number of mature pods, total dry matter per plant, 100 pod weight and 100 kernel weight, while the tester Kalahasti registered high *per se* and GCA for three metric traits namely, days to maturity, sound mature kernel and shelling percentage. The estimate of GCA effects and *per se* performance of the parents for different traits would enable the breeder to understand its genetic architecture. These parental lines are worth utilizing in breeding programmes aimed at pod yield improvement by following appropriate crossing programme in all possible combinations. The additive genetic component of variance that is available in these parents could very well be exploited following the pedigree breeding methodology.

The estim.ates of SCA effects are presented in Table 3. The cross combinations Vemana x Kalahasti, Tirupati-1 x Tirupati-3 and JL-24 X Narayani exhibited high *per se* and significant SCA effects for pod yield per plant. The cross combinations that showed high *per se* and significant and desirable SCA effects for vaious traits include Vemana x Kalahasti for height of the

Table 2: Estimates of general combining abililty (GCA) effects of parents for different characters in groundnut.

Source of variation	Days to 50% Flowering	Days to maturity	Height of the main axis	No. of pri-mary bran-ches	No. of secondary bran-ches	No. of mature pods	No. of immature pods	TDMP	H.I	SMX	100 pod weight	Shelling %	100 kernel wt.	Oil con-tent	Pod yield / plant
Lines :															
Vemana	0.73	-0.49	0.240	-0.27**	-0.03	-0.89**	0.05	-7.16**	1.82**	-0.03	-0.46*	0.86	-0.22	0.47	-0.71
Kadiri-4	-2.16**	-3.82**	-1.670**	0.20*	0.56**	-0.43*	0.12	1.66**	2.12**	-1.24**	-0.30	0.26	-0.44	0.05	1.98**
Tirupati-1	0.62	1.29	-0.620	-0.02	0.03	1.45**	0.39**	5.00**	-1.26**	1.52**	-5.44**	0.38	-4.02**	-0.26	0.33
Tirupati-4	0.40	0.84	2.040**	0.10	-0.19**	1.50**	-0.08	3.71**	-2.06**	-0.02	0.20	0.17	0.89**	-1.20**	-0.47
JL-24	0.40	2.18**	0.010	-0.01	-0.36**	-1.63**	-0.48**	-3.22**	-0.62	-0.22	6.01**	-1.67	3.81**	0.95*	-1.12**
S.E.	0.37	0.49	0.470	0.09	0.06		0.09	0.37	0.31	0.30	0.18	0.28	0.23	0.44	0.35
Tester:						0.18									
Tirupati-3	1.04**	3.93**	0.540	0.32**	0.48**	0.05	0.20**	0.50	0.28	-1.11**	0.19	-1.47**	-1.76**	-0.39	0.10
Narayani	-0.55	-1.87**	-0.296	-0.31**	0.01	0.25	-0.20**	0.84**	-0.65*	-0.26	0.32*	0.98**	1.88**	0.39	-0.03
Kalahasti	-0.48	-2.07**	-0.270	-0.01	-0.50**	-0.30*	0.00**	-1.34	0.36	1.37**	-0.50**	0.49*	-0.11	-0.00	-0.07
S.E.	0.28	0.38	0.360	0.07	0.04	0.14	0.07	0.28	0.24	0.23	0.14	0.22	0.18	0.34	0.27

* = Significant at 5% level, ** = Significant at 1% level

Table 3: Estimates of specific combining abililty (SCA) effects for different characters in hybrids.

Source of variation	Days to 50% Flowering	Days to matu-rity	Height of the main axis	No. of primary bran-ches	No. of secondary bran-ches	No. of mature pods	No. of immature pods	TDMP	H.I	SMX	100 pod weight	Shelling %	100 kernel wt.	Oil con-tent	Pod yield / plant
Vemana x Tirupati	1.07	0.96	1.68*	-0.25	0.85**	-0.58	-0.13	-3.83**	1.98**	-2.66**	-0.66*	0.94	0.11	-3.78**	-0.49
Vemana x Narayani	-0.00	0.76	1.94*	0.18	-0.68**	-1.18**	-0.53**	-2.19**	-2.88**	0.32	0.21	-0.41	0.33	1.92*	-1.82**
Vemana x Kalahasti	-1.07	-1.71**	-3.62**	0.07	-0.16	1.76**	0.67**	6.01**	0.90	2.34**	0.44	-0.53	-0.44	1.85*	2.31**
Kadiri-4 x Tirupati-3	0.62	-0.71	-0.84	0.08	-0.75**	2.55**	-0.00	1.59*	-0.92	0.32	-1.68**	-0.16	-0.91*	-0.05	-0.07
Kadiri-4 x Narayani	-0.78	0.42	-0.69	-0.29	0.52**	-2.25**	0.40**	0.27	0.42	-0.84	0.81*	0.09	0.03	-0.21	0.13
Kadiri-4 x Kalahasti	0.16	0.29	1.53	0.20	0.24*	-0.30	-0.40**	-1.86**	0.50	0.52	0.88**	0.07	0.88*	0.26	-0.06
Tirupati-1 x Tirupati-3	-0.82	1.51**	0.26	0.11	-0.02	0.66*	0.13	4.92**	0.06	3.38**	-0.71*	-0.08	-0.99*	2.90**	1.70**
Tirupati-1 x Narayani	0.44	-0.02	-0.74	0.07	0.05	-0.94**	0.33**	-2.13**	0.80	-1.90**	0.19	0.13	0.38	-1.14	-0.46
Tirupati-1 x Kalahasti	0.38	-1.49**	0.48	-0.17	-0.03	0.28	-0.47**	-2.78**	-0.85	-1.48**	0.52	-0.05	0.61	-1.76*	-1.24
Tirupati-4 x Tirupati-3	-0.60	-0.38	-1.23	-0.03	0.14	0.02	0.20	0.10	-0.23	-0.86	0.18	-0.67	2.10**	-0.21	0.27
Tirupati-4 x Narayani	0.33	-0.91	0.40	-0.07	-0.13	0.22	0.00	-0.15	0.44	1.11**	0.05	0.18	-0.78	0.11	0.02
Tirupati-4 x Kalahasti	0.27	1.29*	0.83	0.09	-0.01	-0.24	-0.20	0.04	-0.21	-0.25	-0.23	0.50	-1.31**	0.10	-0.29
JL-24 x Tirupati-3	-0.27	-1.38**	0.13	0.08	-0.22*	-2.65**	-0.20	-2.78**	-0.88	-0.18	2.87**	-0.03	-0.31	1.13	-1.40*
JL-24 x Narayani	-0.00	-0.24	-0.91	0.11	0.25	4.15**	-0.20	4.19**	1.23*	1.31**	-1.26**	0.02	0.04	-0.68	2.12**
JL-24 x Kalahasti	0.27	1.62	0.78	-0.20	-0.03	-1.50**	0.40	-1.41*	-0.35	-1.13**	-1.61**	0.01	0.27	-0.46	-0.71
SE	0.64	0.85	0.82	0.16	0.10	0.31	0.15	0.64	0.54	0.51	0.32	0.49	0.40	0.76	0.61
CD (0.05)	1.83	2.44	2.34	0.46	0.30	0.89	0.44	1.83	1.55	1.48	0.91	1.41	1.15	2.19	1.76

* = Significant at 5% level, ** = Significant at 1% level

main axis, Vemana x Tirupati-3, Kadiri-4 x Narayani and Kadiri-4 x Kalahasti for number of secondary branches, Kadiri-4 x Tirupati-3, Tirupati-1 x Tirupati-3, JL-24 x Narayani for number of mature pods and total dry matter per plant, Vemana x Tirupati-3 for harvest index, Kadiri 4 x Tirupati-3, Tirupati-1 x Tirupati-3, JL 24 x Narayani and Vemana x Kalahasti for sound mature kernel percent, Kadiri-4 x Narayani, Kadiri-4 x Kalahasti and Jl-24 x Tirupati-3 for 100 pod weight, Tirupati-4 x Tirupati-3 for 100 kernel weight, Vemana x Narayani, Vemana x Kalahasti, Tirupati-1 x Tirupati-3 for oil percentage. In general, most of the cross combinations with significant SCA were obtained from parents involving high and low general combiners (high x low, low x high and low x low) for most of the traits including pod yield per plant. This indicated due to non-additive as well as additive x non-additive gene interaction, intercrossing of selected segregants in all possible combinations (biparental mating system) and recurrent selection procedure followed by pedigree method could improve the yield in high x low, low x high and low x low cross combinations.

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Application of Proteins as Biochemical Markers for DUS Testing of Rice (*Oryza sativa* L.) Varieties

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ABSTRACT

Characterization of 33 rice varieties which are cultivated in different agro-ecosystems were undertaken using biochemical maker system *i.e.*, total soluble protein profile. The average similarity index, average heterozygousity values for polymorphic loci were 0.50 and 0.54, respectively. The protein marker system generated 24 polymorphic markers (75%) out of a total of 32 bands. The probability of obtaining an identical match by chance between two genotypes was 5×10^{-2}. The possible application of these markers for DUS (distinctness, uniformity and stability) testing for the grant of plant variety protection is discussed.

Key words : Rice, Total Soluble Protein, DUS testing

Varietal identification has attained a critical importance in India in view of the increasing multiplicity of varieties and imminent implementation of the Protection of Plant Varieties and Farmers' Rights Act, 2001. A breeder's variety must fulfil the criteria of distinctness, uniformity and stability (DUS) to be given protection under this act.

Accurate identification keys based only on morphological and physiological parameters with clear-cut features of distinctness are not always possible. Thus, other characteristics obtained with the help of new laboratory technologies supplement the need for precise description. Gel electrophoresis of proteins is a powerful tool to distinguish between genotypes of plant species (Cooke, 1995). The proteins being direct gene products, reflect the genomic composition of varieties and hence are good candidates for varietal distinctness.

The use of protein markers is recommended for variety characterization in several crops. But these have not yet been included by the UPOV for establishing uniqueness of rice varieties.

Rice is one of the important crop plants where detailed protein analysis has been conducted and exhaustive information on the method of analysis and genetic control is available. Various workers have employed electrophoretic profiles of total soluble proteins for varietal identification in rice (Malik and Kush, 1996; Habib *et. al.*, 2000). Thus, the present study was conducted with the aim to distinguish rice varieties using Tris-soluble seed protein profiles to assess their uniformity and stability.

MATERIAL AND METHODS

Electrophoresis of soluble proteins

The experiment for identification of rice varieties on the basis of electrophoregrams of soluble seeds protein was carried out at Andhra Pradesh Rice Research Institute (APRRI), Maruteru. Seeds of each variety were crushed and powdered using pestle and mortar. Seed powder (0.5 g) was vigorously mixed in Tris (pH 7.5) (1 ml) for 10 minutes with simultaneous addition of SDS (100 µl) and mercapto ethanol (50 µl). After this it was kept in water bath for 1 hr. Later it was centrifused at 6000 RPM for 20 minutes. The clear supernatant was used as protein sample for electrophoretic analysis.

Discontinuous polyacrylamide slab gel electrophoresis (DPAGE) was carried out according to standard method (Dodlani and Varier, 1993) using 10% acrylamide separating gel (0.5 M Tris-HCl buffer pH 8.8) with a top layer of 10% acrylamide stacking gel (0.5 M Tris-HCl buffer pH 6.8). The standardized volume of protein sample (30 µl) was loaded on slab gel wells. Electrophoresis was conducted at a constant current of 36 mA for 45 minutes and then raised to 58 mA until the tracking dye (bromophenol blue) migrated to the anode end of the slab gel. The staining was done for 2 hours in coomassie brilliant blue R-250 (CBBR) solution (0.5 g CBBR dye was dissolved in 250 ml methanol, 10 ml acetic acid and 240 ml water). The gels were destained by repeated washing with methanol : acetic acid : water (50 : 70 : 880 v/v/v, respectively).

Statistical analysis of biochemical markers

Bands were scored as present (1) or absent (0) and data entry was done into a binary matrix

Table 1 : Source or origin for 34 rice genotypes under study.

S.No.	Genotype	Source
1	JGL 384	Jagitial, Andhra Pradesh
2	ARC 6605	Assam
3	TKM 6	Tamil Nadu
4	Annada	CRRI, Hazaribagh
5	N 22	Uttar Pradesh
6	Rajendra	ARI, Rajendranagar, Andhra Pradesh
7	MTU 1010	APRRI, Mariteru, Andhra Pradesh
8	Prasanna	DRR, Hyderabad, Andhra Pradesh
9	Pusa Basmati	IARI, New Delhi
10	Putikabari	Land Race of Eastern UP
11	Vandana	CRRI, Hazaribagh
12	Rudrama	Rudrur, Andhra Pradesh
13	Naveen	CRRI, Cuttack, Orissa
14	Heera	CRRI, Cuttack, Orissa
15	Anjali	CRRI, Hazaribagh
16	Aditya	DRR, Hyderabad, Andhra Pradesh
17	Rasi	DRR, Hyderabad, Andhra Pradesh
18	MTU 1006	APRRI, Maruteru, Andhra Pradesh
19	Dular	West Bengal
20	Ravi	DRR, Hyderabad, Andhra Pradesh
21	Lalnakanda 41	Punjab
22	MTU 1001	APRRI, Maruteru, Andhra Pradesh
23	Bhadraj	Not known
24	MTU 3626	APRRI, Maruteru, Andhra Pradesh
25	Salempiket	IRRI, Philippines
26	IR 64	IRRI, Philippines
27	Moroberkan	Japonica Variety, Guinea of West Africa
28	3626 / Dular	--
29	1001-Ravi	--
30	1001 / Bhadraj	--
31	3626 / Salempiket	--
32	IR 64 / Bhadraj	--
33	3626 / L41	--
34	1001 / MB	--

as discrete variables. Jaccard's coefficient of similarity was measured and a dendrogram was generated using unweighted pair group method with arithmetic average (UPGMA). The computer package NTSYS-PC version 1.80 (Rohlf, 1993) was used for cluster analysis to measure the relationship between the varieties. The expected heterozygosity, $H_n = 1\text{-}Pi^2$, where Pi is the allele frequency of i^th^ allele (Powell *et. al.*, 1996).

The arithmetic mean heterozygosity for polymorphic loci, (H_{av}) p was calculated as (H_{av}) P = Hn/np, where np is the number of polymorphic loci analyzed. Marker index (MI) is calculated as MI = E (H_{av})P, where E is the effective multiplex ratio $(E=n^2)$, where P is the fraction of polymorphic loci (Powell *et. al.*, 1996).

The probabilities of two genotypes being identical by chance were calculated by the formula (X_D) N, where X_D is average similarity index and N is average number of bands per genotypes (Wetton *et. al.*, 1987).

RESULTS AND DISCUSSION

SDS-PAGE profiles of tris soluble proteins

The electrophoresis of total soluble seed proteins revealed a moderate degree of polymorphism among the rice varieties studied. The scoring was done for the presence or absence of bands, which are identified by their respective mobility and numbered in sequence from cathodal origin. SDS PAGE revealed 32 electrophoretic bands. None of the genotype showed all the protein bands. Maximum number of bands (24) in ARC 6605, and minimum number of bands (11) in Naveen and Prasanna were observed (Table 2 and 3). On the basis of protein electrophoregram, protein band numbers 1, 12, 14, 16, 27, 29, 31 and 32 were observed to be universally present in all 33 genotypes studied, indicating the genes controlling the expression of these protein bands appeared to behave a single block as also revealed in rice (Padmavathi *et. al.*, 1999). On the other hand protein band numbers 6, 7, 8, 10, 11, 13, 15, 17, 18, 19, 20, 22, 24, 25 were useful for discriminating varieties.

Band number 2 (MW 68 KD) was present only in three genotypes *i.e.*, JGL 384, Pusa Basmati and ARC 6605 band number 3 (MW 63 KD) was present only in two genotypes *i.e.*, JGL 384 and ARC 6605. Band number 4 (MW57 KD) was present only in 2 genotypes Pusa Basmati and ARC 6605. Band number 9 (MW 38 KD) was present only in one genotype Lalnakanda 41. Band number 21 (MW 16 KD) was present only in three genotypes *i.e.*, Pusa Basmati, ARC 6605 and MTU 1010. Band number 23 (MW 18 KD) was present only in four genotypes *i.e.*, Ravi, 1001/Ravi, 1001/Bhadraj, Annada. Band number 30 (MW 11 KD) was present only in ARC 6605.

A comparative study between hybrids and parents is also shown in Table 4. All the hybrids showing much similarity with their parents by exhibiting parental bands confirms their hybridity. On the other hand, rice varieties *viz.*, Naveen and Prasanna, 3626/Lalnakanda-41 and Dular, Anjali and Aditya displayed a different kind of situation as they had identical banding pattern in their electrophoregrams indicating their high order of closeness in seed protein polymorphism/profile. Therefore, clear discrimination between these genotypes work on slab electrophoresis under denaturing conditions or by PCR based DNA finger printing is needed.

Cluster analysis

Using biochemical data, cluster analysis was performed using NTSYS-PC version 1.80 (Rohlf, 1993) based on total soluble proteins. Dendrogram was constructed to show genetic relationships within the rice genotypes (Fig.3). Thirty three rice genotypes were grouped into six clusters A, B, C, D, E and F comprising 13, 4, 8, 4, 1 and 3 genotypes. The clustering of varieties did not show any specific pattern either respect to the agro-ecosystem or time to flowering.

Efficiency of biochemical markers

The total number of bands analysed was thirty two, out of which twenty four (75%) were polymorphic. Pairwise similarity indices calculated among 33 varieties using profiles of total soluble protein and it showed maximum similarity index value of 1.00 between Naveen and Prasanna, 3626/Lalnakanda-41 and Dular, Anjali and Aditya and a minimum value of 0.214 was observed between Anjali and Putikabari (Table 5). The average similarity index value was 0.50 showing its greater ability to discriminate varieties as compared to morphological markers, while arithmetic mean heterozygosity for polymorphic loci was 0.54. The probability of obtaining identical profiles between two varieties was calculated to be 5 x 10^{-2}, suggesting that the probability of obtaining identical profiles between two varieties was 5 for every 100 varieties compared. Thus, efficiency of biochemical marker systems for characterization of rice varieties can be considered to be moderate.

Uniformity and stability of biochemical markers

A marker used for establishing varietal distinctness must be

Table 2 : Protein banding pattern of rice genotypes.

Genotypes	Molecular weight KD	97	68	64	57	48	43	42	40	38	34	31	29	28	27	26	25
	Band Nos.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	RM value	0.063	0.137	0.186	0.241	0.282	0.296	0.31	0.33	0.34	0.35	0.38	0.448	0.468	0.475	0.496	0.524
LNK		++	--	--	--	--	+	+	+++	+	+	++	++	+++	++	+	+++
3626/LNK		++	--	--	--	--	+	+	+++	--	--	++	++	+++	++	+	+++
3626		++	--	--	--	--	--	--	+++	--	--	++	++	+++	++	+	+++
DULAR		++	--	--	--	--	+	+	+++	--	--	++	++	+++	++	+	+++
3626/DULAR		++	--	--	--	--	++	--	+++	--	--	++	++	+++	++	+	+++
3626/SP		++	--	--	--	--	--	+	+++	--	--	++	++	+++	++	+	+++
SP		++	--	--	--	--	--	--	+++	--	--	++	++	+++	++	+	+++
RAVI		++	--	--	--	--	--	++	+++	--	--	++	++	+++	++	-	+++
1001/RAVI		++	--	--	--	--	++	+	+++	--	--	++	++	+++	++	-	+++
1001		++	--	--	--	--	--	+	+++	--	--	++	++	+++	++	+	+++
1001/MB		++	--	--	--	--	+	+++	+++	--	--	++	++	+++	++	+	+++
MB		++	--	--	--	--	--	--	+++	--	+	++	++	+++	++	+	+++
1001/BAD		++	--	--	--	--	--	+++	+++	--	--	++	++	+++	++	-	+++
BAD		++	--	--	--	--	--	--	+	--	--	++	++	+++	++	+	+++
IR64/BAD		++	--	--	--	--	--	--	--	--	--	++	++	+++	++	+	+++
IR64		++	--	--	--	--	++	+++	++	--	+	++	++	+++	++	+	+++
ANNADA		++	--	--	--	+	+++	+++	++	--	+	++	++	+++	++	+	++
ANJALI		++	--	--	--	--	--	--	++	--	--	--	+++	--	++	-	++
ADITYA		++	--	--	--	--	--	--	++	--	--	--	+++	--	+++	-	++
HEERA		++	--	--	--	--	--	--	++	--	+++	--	+++	--	+++	+	++
JGL 384		++	+	+	--	+	+	--	++	--	+++	+	+++	--	+++	-	++
NAVEEN		++	--	--	--	--	--	--	++	--	+++	--	+++	--	+++	-	++
N22		++	--	--	--	--	--	--	++	--	++	++	+++	--	+++	+	++
PRASANNA		++	--	--	--	--	--	--	++	--	++	--	+++	--	+++	-	+
PKB		++	--	--	+	+	+	--	++	--	++	--	+++	--	+++	-	+
PB		++	++	--	--	--	--	--	++	--	+++	++	+++	+	+++	+	+
RAJENDRA		++	--	--	--	--	--	--	++	--	+++	--	+++	--	+++	-	+
RUDRAMA		++	--	--	--	--	--	--	++	--	++	--	+++	--	+++	-	+
VANDANA		++	--	--	--	--	--	--	++	--	+	--	+++	--	+++	-	+
TKM6		++	--	--	--	--	--	--	++	--	++	--	+++	--	+++	-	+
MTU 1006		++	--	--	--	--	--	--	++	--	++	--	+++	--	+++	+	+
ARC 6605		++	++	+	+	+	+	--	++	--	+++	++	+++	--	+++	+	+
1010		++	--	--	--	--	--	--	++	--	+++	--	+++	+	+++	-	+

contd..

Table 2 Contd..

Genotypes / Molecular weight KD	24	23	22	21	20	19	18	17	16	15	14	13	11	10	9	7
Band Nos.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
RM value	0.537	0.551	0.558	0.565	0.579	0.6	0.601	0.602	0.63	0.64	0.65	0.7	0.74	0.77	0.78	0.84
LNK	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
3626/LNK	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
3626	++	+	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
DULAR	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
3626/DULAR	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
3626/SP	++	+	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
SP	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
RAVI	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
1001/RAVI	++	+	+	--	--	+	+++	--	--	--	+++	--	+++	--	+++	+++
1001	++	--	+	--	--	+	+++	--	--	--	+++	--	+++	--	+++	+++
1001/MB	++	--	+	--	--	--	--	--	--	--	+++	--	+++	--	+++	+++
MB	++	--	+	--	--	+	--	--	--	--	+++	+++	+++	--	+++	+++
1001/BAD	++	--	+	--	--	+	--	--	--	--	+++	+++	+++	--	+++	+++
BAD	++	+	-	--	--	--	+++	--	+++	--	+++	+++	+++	--	+++	+++
IR64/BAD	++	+	+	--	--	--	--	--	+++	--	+++	+++	+++	--	+++	+++
IR64	++	+	-	--	--	--	--	--	+++	--	+++	+++	+++	--	+++	+++
ANNADA	++	--	+	--	--	+	--	--	+++	--	+++	--	+++	--	+++	+++
ANJALI	--	--	+	--	--	+	+++	--	+++	--	+++	--	++	--	+++	+++
ADITYA	--	--	+	--	--	+	--	--	+++	--	+++	--	++	--	+++	+++
HEERA	--	--	-	+	--	+	--	--	+++	--	+++	--	++	--	+++	+++
JGL 384	--	--	+	--	--	--	--	--	+++	--	+++	---	++	--	+++	+++
NAVEEN	--	--	-	--	--	--	--	--	+++	--	+++	--	+++	--	+++	+++
N22	--	--	+	+	--	+	--	+++	+++	+++	+++	---	+++	--	+++	+++
PRASANNA	--	--	-	-	--	--	--	--	+++	--	+++	--	+++	--	+++	+++
PKB	--	--	-	++	--	--	--	--	--	+++	+++	--	+++	--	+++	+++
PB	--	--	+	-	++	--	--	--	+++	--	+++	--	+++	--	+++	+++
RAJENDRA	--	--	+	-	--	--	--	+++	+++	--	+++	--	+++	--	+++	+++
RUDRAMA	--	--	+	-	--	+	--	+++	+++	--	+++	--	+++	--	+++	+++
VANDANA	--	--	-	-	--	+	--	--	+++	--	+++	--	+++	--	+++	+++
TKM6	--	--	+	-	--	--	--	--	+++	--	+++	--	+++	--	+++	+++
MTU 1006	--	--	+	+	--	+	--	--	+++	--	+++	--	+++	--	+++	+++
ARC 6605	--	--	+	+	+	+	--	+	+++	--	+++	--	+++	+++	+++	+++
1010	--	--	+	+	+	+	--	+	+++	--	+++	--	+++	--	+++	+++

reproducible and expressed uniformly. A few genotypes *viz.*, Naveen and Prasanna, Anjali and Aditya, 3626/Lalnakanda 41 and Dular showed complete uniformity (100% between them. A uniform pattern was observed, except for some varieties with respect to intensity of bands. Remaining all genotypes showed a little uniformity between them and expressed their own identity.

SDS-PAGE is, thus, a simple but useful technique, which can be used for identification and characterization of rice varieties and has been used for other crop species (Nagaraju *et. al.*, 2000). ISTA (1999) has recommended SDS-PAGE as a standard method for verifying the identity of varieties of tris soluble proteins in pisum and lolium. UPOV (1994) has recommended SDS-PAGE for high molecular weight glutenins in wheat. In case of rice, it appears to be useful for the grouping of varieties for further characterization.

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Banding pattern of rice genotypes

Plate - 1

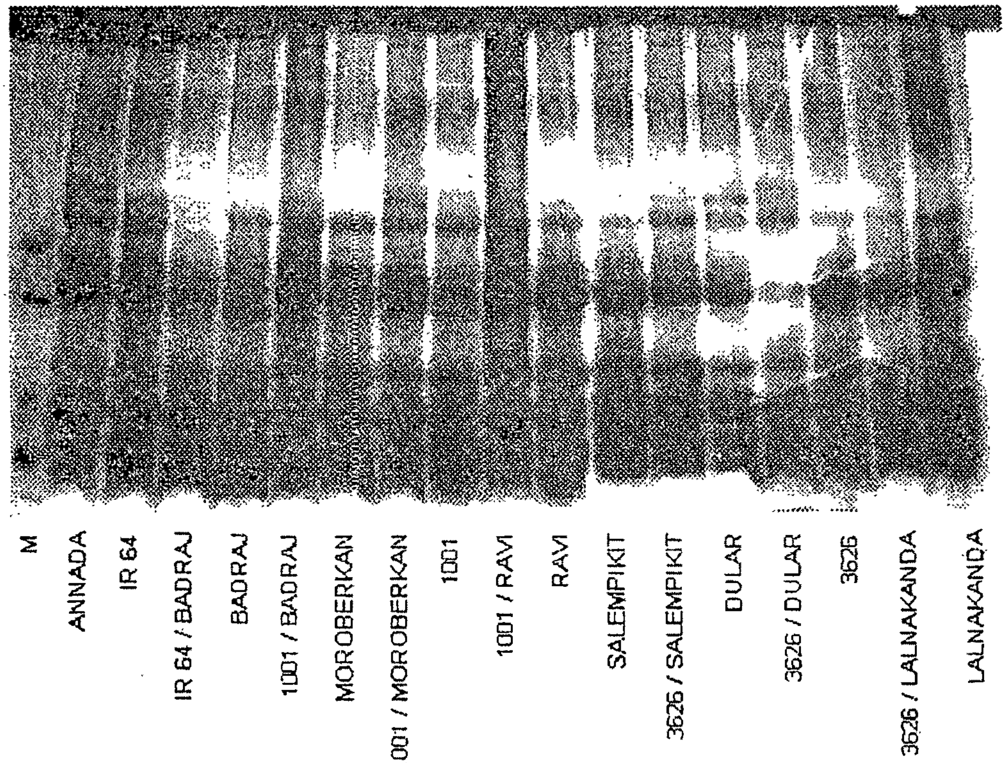
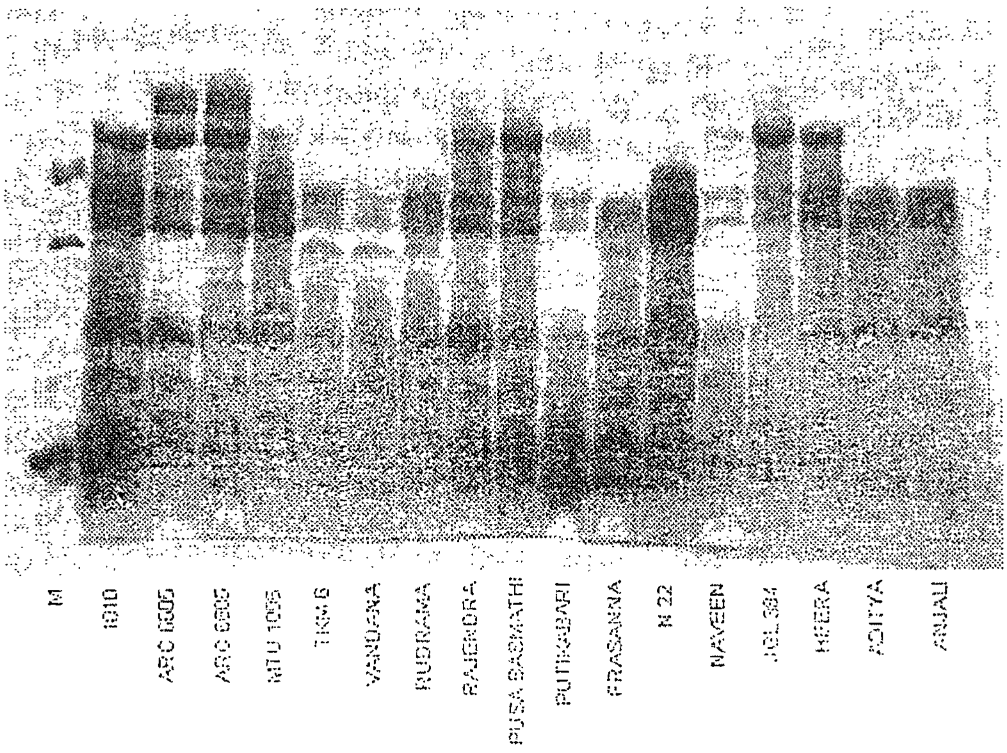


Plate - 2



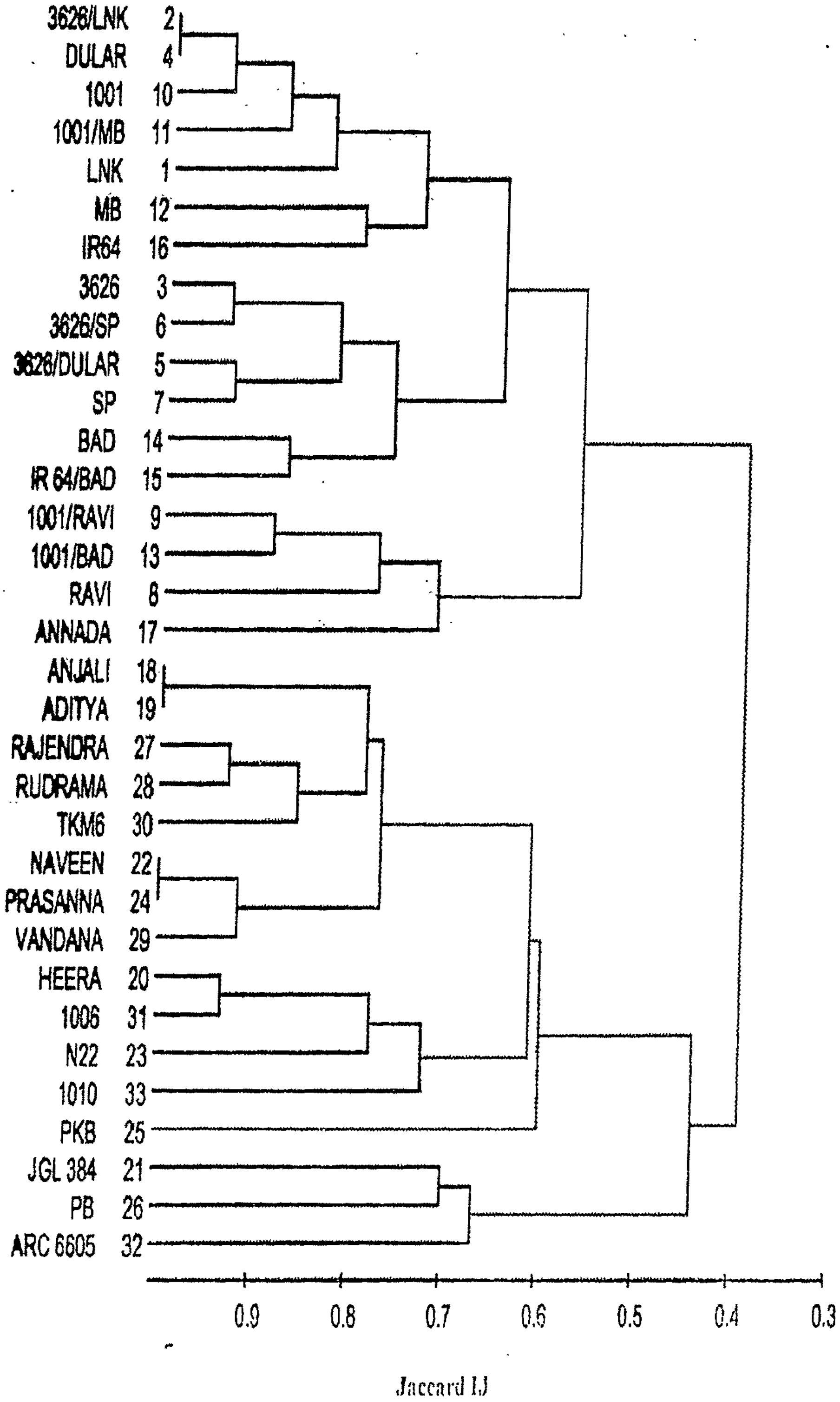


Fig. 2 : Complete linkage dendrogram of 33 Rice genotypes based on Jaccard's coefficient values

Table 4: Jaccard's similarity matrix of rice genotypes

Geno-types	Ink	3626 /Ink	3626	Dular	3626/ Dular	3626 /SP	SP	Ravi	1001/ Ravi	1001	1001/ MB	MB	1001/ BAD	BAD	IR64/ BAD	IR64	ANNADA	ANJALI	ADITYA	HEERA	JGL 384	NAVEEN	N22	PRASANNA	PKB	PB	RAJENDRA	RUDRAMA	VANDANA	TKM6	1006	ARC 6605	1010
Lnk	1.000																																
3626/link	0.111	1.000																															
3626	0.263	0.176	1.000																														
Dular	0.111	1.000	0.176	1.000																													
3626/Dular	0.167	0.063	0.125	0.063	1.000																												
3626/SP	0.211	0.118	0.063	0.118	0.176	1.000																											
SP	0.222	0.125	0.067	0.125	0.067	0.125	1.000																										
Ravi	0.263	0.278	0.333	0.278	0.333	0.278	0.294	1.000																									
1001/Ravi	0.333	0.263	0.222	0.263	0.316	0.167	0.278	0.222	1.000																								
1001	0.158	0.059	0.222	0.059	0.118	0.167	0.176	0.316	0.211	1.000																							
1001/MB	0.167	0.063	0.125	0.063	0.125	0.083	0.067	0.235	0.222	0.118	1.000																						
MB	0.200	0.211	0.263	0.211	0.167	0.300	0.222	0.350	0.333	0.158	0.263	1.000																					
1001/BAD	0.333	0.263	0.316	0.263	0.316	0.263	0.278	0.222	0.111	0.211	0.222	0.250	1.000																				
BAD	0.350	0.278	0.125	0.278	0.235	0.176	0.188	0.421	0.316	0.316	0.235	0.263	0.316	1.000																			
IR64/BAD	0.350	0.278	0.125	0.278	0.235	0.176	0.188	0.421	0.316	0.316	0.235	0.263	0.316	0.125	1.000																		
IR64	0.200	0.211	0.263	0.211	0.263	0.211	0.316	0.350	0.333	0.250	0.263	0.200	0.333	0.167	0.263	1.000																	
ANNADA	0.227	0.238	0.364	0.238	0.286	0.318	0.333	0.286	0.273	0.190	0.286	0.227	0.273	0.435	0.435	0.304	1.000																
ANJALI	0.500	0.444	0.412	0.444	0.412	0.444	0.375	0.500	0.389	0.389	0.412	0.421	0.389	0.500	0.500	0.571	0.429	1.000															
ADITYA	0.500	0.444	0.412	0.444	0.412	0.444	0.375	0.500	0.389	0.389	0.412	0.421	0.389	0.500	0.500	0.571	0.429	1.000	1.000														
HEERA	0.476	0.500	0.474	0.500	0.474	0.500	0.444	0.550	0.524	0.450	0.474	0.400	0.524	0.474	0.550	0.476	0.409	0.267	0.267	1.000													
JGL 384	0.455	0.476	0.450	0.476	0.450	0.476	0.421	0.450	0.500	0.500	0.450	0.455	0.500	0.524	0.524	0.522	0.391	0.353	0.353	0.421	1.000												
NAVEEN	0.474	0.500	0.471	0.500	0.471	0.500	0.438	0.471	0.526	0.526	0.471	0.474	0.526	0.471	0.556	0.474	0.476	0.231	0.231	0.214	0.313	1.000											
N22	0.435	0.455	0.429	0.455	0.429	0.455	0.400	0.500	0.478	0.409	0.429	0.364	0.478	0.500	0.500	0.500	0.375	0.333	0.333	0.222	0.381	0.389	1.000										
PRASANNA	0.474	0.500	0.471	0.500	0.471	0.500	0.438	0.471	0.526	0.526	0.471	0.474	0.526	0.471	0.556	0.474	0.476	0.231	0.231	0.214	0.313	1.000	0.389	1.000									
PKB	0.500	0.526	0.500	0.526	0.500	0.526	0.471	0.500	0.550	0.550	0.500	0.500	0.550	0.500	0.579	0.500	0.565	0.400	0.400	0.267	0.444	0.231	0.333	0.231	1.000								
PB	0.286	0.300	0.350	0.300	0.263	0.381	03126	0.429	0.478	0.333	0.350	0.286	0.478	0.429	0.429	0.364	0.304	0.421	0.421	0.400	0.300	0.389	0.364	0.389	0.500	1.000							
RAJENDRA	0.450	0.474	0.444	0.474	0.444	0.474	0.412	0.444	0.500	0.500	0.444	0.450	0.500	0.526	0.526	0.524	0.455	0.214	0.214	0.313	0.294	0.154	0.278	0.154	0.333	0.368	1.000						
RUDRAMA	0.476	0.500	0.474	0.500	0.474	0.500	0.444	0.474	0.450	0.450	0.474	0.400	0.450	0.550	0.550	0.545	0.409	0.143	0.143	0.250	0.333	0.214	0.222	0.214	0.375	0.400	0.071	1.000					
VANDANA	0.500	0.526	0.500	0.526	0.500	0.526	0.471	0.500	0.474	0.474	0.500	0.421	0.474	0.500	0.579	0.500	0.429	0.154	0.154	0.143	0.353	0.083	0.333	0.083	0.286	0.421	0.214	0.143	1.000				
TKM6	0.421	0.444	0.412	0.444	0.412	0.444	0.375	0.412	0.474	0.474	0.412	0.421	0.474	0.500	0.500	0.500	0.429	0.154	0.154	0.267	0.250	0.083	0.333	0.083	0.286	0.333	0.077	0.143	0.154	1.000			
1006	0.429	0.450	0.421	0.450	0.421	0.450	0.389	0.500	0.476	0.400	0.421	0.350	0.476	0.500	0.500	0.500	0.364	0.200	0.200	0.067	0.368	0.267	0.167	0.267	0.313	0.350	0.250	0.188	0.200	0.200	1.000		
ARC	0.500	0.519	0.556	0.519	0.500	0.571	0.538	0.607	0.586	0.481	0.556	0.444	0.586	0.607	0.607	0.552	0.393	0.500	0.500	0.417	0.333	0.542	0.320	0.542	0.560	0.320	0.458	0.417	0.500	0.500	0.375	1.000	
1010	0.478	0.500	0.476	0.500	0.476	0.500	0.450	0.476	0.455	0.455	0.476	0.409	0.455	0.545	0.545	0.542	0.417	0.294	0.294	0.278	0.429	0.353	0.250	0.353	0.389	0.409	0.235	0.176	0.294	0.294	0.22	0.360	1.000

Table 3 : A comparative study among the parents and hybrdis.

Genotypes /Total No.of bands	Bands common in parents hybrids	Bands present in hybrid & absent in parent 1	Bands present in hybrid & absent in parent 2	Bands present only in hybrid	Bankds present in parent 1 only	Bankds present in parent 2 only	Remarks
1. MTU 3626 (p_1)15 2. 3626/Lalnakanda 16 3.Lalnakand 41 (p_2) 18	14	Band No.6&7 (Rm 0.296, 0.31) (43 & 42 KD)	---	---	Band No.18 (Rm 0.551) (23 KD)	Band No.9&10 (Rm 0.340,0.35) (38,34 KD)	Hybridity is present
1. MTU 3626 (p_1) 15 2. 3626/Dular 15 3. Dular (p_2) 16	14	Band No. 6 (Rm 0.296) (43 KD)	---	---	Band No.18 (Rm 0.551) (23 KD)	Band No.7 (Rm 0.31) (42 KD)	Hybridity is present
1. MTU 3626 (p_1) 15 2. 3626/Salempikit 16 3. Salempikit (p_2)14	14	---	Band No.18 (Rm 0.551) (23 KD)	Band No.7 (Rm 0.31) (42 KD)	---	---	Hybridity is present
1. MTU 1001(p_1) 16 2. 1001/Ravi 17 3. Ravi(p_2) 17	17	Band No. 23 (Rm 0.61)(18KD)	Band No.22 (Rm 0.6)(19 D)	---	Band No.6,15 (Rm 0.296, 0.496) with MW (43, 26 KD)	Band No.10 (Rm 0.35) with MW (34KD)	Hybridity is present
1. MTU 1001(p_1) 17 2. 1001/Moroberkan 15 3. Moroberkan(p_2) 18	14	---	Band No 7 (Rm 0.31) (42 KD)	---	Band No.6,22 (Rm 0.296, 0.558) with MW (43, 19 KD)	Band No.6,22,28 (Rm 0.296, 558, 0.7) with MW (43,19,13 KD)	Hybridity is present
1. MTU 1001 (p_1)17 2. 1001/Bhadraj 17 3. Bhadraj (p_2) 15	12	Band No 28 (Rm 0.7)(KD)	Band No 7, 19, 22 (Rm0.496) with0. 31,0.558, 0.61) with MW (42, 19, 22KD)	Band No 15 (Rm 0.496) with MW (26 KD)	Band No.6,15 (Rm 0.296, 0.496) with MW (43, 26 KD)	Band No.15 (Rm 0.496) with MW (26 KD)	Hybridity is present
1. IR 64 (p_1) 18 2. IR 64/Bhadraj 15 3. Bhadraj (p_2) 15	14	---	---	Band No 19 (Rm 0.558) with MW (22KD)	Band No.6,7,8, 10 (Rm 0.296, 0.31, 0.33, 0.35) with MW (43, 42, 40, 34KD)	Band No.8(Rm 0.33) with MW (40 KD)	Hybridity is present

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Classical and Restriction Selection Indices in AICSMIP Group of Genotypes of Finger Millet [*Eleusine coracana* (L.) Gaertn.]

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ABSTRACT

In fifty diverse genotypes of finger millet obtained from All Indian Coordinated Small Millets Improvement Project (AICSMIP, Bangalore) GE genotypes) using discriminant function technique revealed that the functions including yield per plant and productive tillers per plant as one of the components recorded high expected genetic advance as well as relative efficiency. The index in which all the nine characters were included except 1000 seed weight showed maximum genetic advance as well as relative efficiency suggesting that simultaneous selection for all these characters would be better over straight selection for yield.

Key words : Selection Indices, Restricted Selection Indices, Genetic Advance and Finger Millet

Considerable emphasis is currently being placed upon the improvement of yield through simultaneous selection for various attributes. The discriminant function affords an efficient method for simultaneous selection (Smith, 1936). Attempts are therefore, made in this investigation to assess the efficiency of different selection indices formulated through the use of the discriminant function technique.

MATERIAL AND METHODS

The present investigation was conducted for two consecutive seasons *i.e., kharif* 2005 and *rabi* 2006 at Agricultural College Farm, Bapatla. Fifty genotypes from All Indian Coordinated Small Millets Improvement Project (AICSMIP, Bangalore) GE (genotypes) were evaluated in randomized block design with four replications. Observations were recorded on five randomly chosen plants for each replication and genotype for plant height, productive tillers per plant, fingers per ear, length of finger, ear weight per plant, yield per plant, length of root at main field (L.R.M), volume of root at main field (V.R.M), volume of shoot at main field (V.S.M), weight of root at main field (W.R.M) and weight of shoot at main field (W.S.M), while, plot means were used for days to 50% flowering, 1000 seed weight, protein content and calcium content. Using single restriction case, in respect of all the 15 characters restriction selection indices were constructed in the present study and the genetic advance was calculated for each character in each restriction according to Singh and Chaudhary (1977).

The mean values of five plants were used construct selection indices based on the Fisher's (1936) discriminant function. Under certain situations the breeder like to effect change in the means of some characters while keeping the means of other characters unchanged. When a character was restricted *i.e.,* the genetic gain is zero ($\Delta G = 0$), the maximization of the correlation between the genetic worth (H) and another function (I) based on the phenotypic performance of various characters was obtained. A solution to this problem of index construction was given by Kempthorne and Nordskog (1959) using log range multiplier.

RESULTS AND DISCUSSION

Classical selection indices

The weighing coefficients (bi) and economic weights (ai) for different characters in finger millet are presented in Table 2. Inverse of mean values for respective characters were considered as allotted weights.

Among the two component character indices combination of yield per plant (X1) with ear weight per plant (X7) showed high genetic advance (0.77) with relative efficiency of (198.74%, 248.39% and 208.11%) over yield per plant, protein % and 1000 seed weight, respectively during *kharif*, 2005. Among the two component character indices combination of productive tillers per plant (X4) with fingers per ear (X5) showed high genetic advance (0.71) with relative efficiency of (246.93%, 229.03% and 197.22%) over yield per plant, protein % and 1000 seed weight, respectively, during *rabi* 2006. Likewise all the combinations are embodied in the Table 1 for *kharif* 2005 and *rabi* 2006.

Table 2 : Weighing coefficients (b_i) and economic weights (a_i) for different characters during kharif 2005 and rabi 2006 in finger millet.

Characters	Weighing coefficietns		Economic weights	
	kharif 2005	rabi 2006	kharif 2005	rabi 2006
Days to 50% flowering	0.0119	0.0032	0.0145	0.0153
Plant height (cm)	0.0120	0.0059	0.0090	0.0094
Productive tillers / plant	0.2158	0.2312	0.1848	0.1890
Fingers / ear	0.0793	0.0278	0.1408	0.1379
Finger length (cm)	0.1826	0.1630	0.1718	0.1703
Ear weight / plant (g)	0.0068	-0.0091	0.0372	0.0334
Yield / plant (g)	-0.0146	-0.0010	0.0496	0.0424
Straw yield / plot (g)	0.0007	0.0010	0.0007	0.0007
1000 seed weight (g)	0.3556	0.4145	0.4255	0.4184
Protein content (%)	0.0782	0.0792	0.1094	0.1092
Calcium content (mg/100g)	0.0041	0.0031	0.0033	0.0033
L.R.M (cm)	0.0039	0.0091	0.0332	0.0323
V.R.M (cc)	0.0216	0.0123	0.0355	0.0318
V.S.M (cc)	0.0079	0.0083	0.0069	0.0067
W.R.M (g)	0.1077	0.0167	0.1432	0.1350
W.S.M (g)	0.0071	-0.0021	0.0125	0.0111

Table 1 : Selection indices for different character combinations of AICSMIP genotypes during kharif 2005 and rabi 2006 (in parentheses) in finger millet.

Character combination	kharif 2005				rabi 2006			
	Genetic Advance	Relative efficiency over			Genetic Advance	Relative efficiency over		
		Yield / plant (%)	Protein %	1000 seed weight		Yield / plant (%)	Protein %	1000 seed weight
Yield/plant (g) X1	0.39	100.00	125.81	105.41	0.29	100.00	93.55	80.56
Days to 50% flowering X2	0.16	40.44	51.61	43.24	0.14	47.92	45.16	38.89
Plant height (cm) X3	0.21	53.74	67.74	56.76	0.21	73.18	67.74	58.33
Productive tillers/plant X4	0.51	131.15	164.52	137.84	0.53	183.83	170.97	147.22
Fingers/ear X5	0.35	90.89	112.90	94.59	0.28	95.54	90.32	77.78
Finger length (cm) X6	0.53	135.23	170.97	143.24	0.52	179.46	167.74	144.44
Ear weight/plant (g) X7	0.39	99.47	125.81	105.41	0.32	110.47	103.23	88.89
1000 seed weight (g) X8	0.37	94.18	119.35	100.00	0.36	124.30	116.13	100.00
Protein content (%) X9	0.31	80.70	100.00	83.78	0.31	105.67	100.00	86.11
Calcium content (mg/100g) X10	0.28	71.60	90.32	75.68	0.28	96.27	90.32	77.78
X1+X7 (x4 + x5)	0.77	198.74	248.39	208.11	0.71	246.93	229.03	197.22
X1+X4+X7 (X1+x4+x5)	1.05	268.88	338.71	283.78	0.89	307.14	287.10	247.22
X1+X4+X7+X9 (X1+x4+x7+x9)	1.18	303.90	380.65	318.92	1.04	357.76	335.48	288.89
X1+X2+X4+X7+X9 (x1+x3+x6+x7+x8)	1.24	317.64	400.00	335.14	1.11	382.04	358.06	308.33
X1+X2+X3+X4+X7+X9 (x1+x2+x3+x6+x7+x8)	1.33	356.75	429.03	359.46	1.18	408.75	380.65	327.78
X1+X2+X3+X4+X6+X7+X9 (x1+x2+x3+x6+x7+x8+x10)	1.39	356.75	448.39	375.68	1.25	430.56	403.23	347.22
X1+X2+X3+X4+X6+X7+X9+X10 (x1+x3+x4+x5+x6+x7+x9+x10)	1.44	368.90	464.52	389.19	1.30	449.64	419.35	361.11
X1+X2+X3+X4+X5+X6+X7+X9+X10 (X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)	1.45	371.15	467.74	391.89	1.33	460.60	429.03	369.44
X1+X2+X3+X4+X5+X6+X7+X8+X9+X10 (X1+X2+X3+X4+X5+X6+X7+X8+X9+X10)	1.45	371.15	467.74	391.89	1.32	456.53	425.81	366.67

Restricted selection indices

The charcterwise weighing coefficients (b_i) values for AICSMIP *kharif* 2005 and AICSMIP *rabi* 2006 are embodied in Table 3. The characterwise genetic advance (ΔG_i) values for AICSMIP *kharif* 2005 and AICSMIP *rabi* 2006 are embodied in Table 4.

AICSMIP *kharif* 2005 genotypes

There was negligible gain for the characters that were restricted during both seasons indicating successful case of restriction of characters.

By restricting days to 50% flowering, highest value of genetic advance was observed for seed protein percentage (198.87) and least value for volume of root at main field (-3.30). By restricting plant height, highest value of genetic advance was observed for length of finger (10.19) and least value for volume of root at main field (-5.75).

By restricting productive tillers per plant, highest value of genetic advance was observed for plant height (94.96) and least value for 1000 seed weight (-67.11) and volume of root at main field (-67.01). By restricting fingers per ear, highest value of genetic advance was observed for seed protein percentage (259.64) and volume of root at main field (259.63) and least value for 1000 seed weight (-18.12) and volume of shoot at main field (-18.17).

By restricting length of finger, highest value of genetic advance was observed for weight of shoot at main field (11.87) and least value for volume of shoot at main field (-9.62). By restricting ear weight per plant, highest value of genetic advance was observed for seed protein percentage (125.33) and weight of shoot at main field (125.33) and least value for yield per plant (-2.87).

By restricting yield per plant, highest value of genetic advance was observed for volume of root at main field (89.01) and least value for productive tillers per plant (-6.17). By restricting 1000 seed weight, highest value of genetic advance was observed for seed calcium content (167.93) and least value for seed protein percentage (-22.82).

By restricting seed protein percentage, highest value of genetic advance was observed for 1000 seed weight (86.66), plant height (86.58) and least value for fingers per ear (-1.13). By restricting seed calcium content, highest value of genetic advance was observed for 1000 seed weight (278.61), productive tillers per plant (278.37) and least value for weight of shoot at main field (-8.21).

By restricting length of root at main field, highest value of genetic advance was observed for volume of root at main field (16.64) and least value for ear weight per plant (-3.49). By restricting volume of root at main field, highest value of genetic advance was observed for ear weight per plant (29.88) and least value for 1000 seed weight (-15.89).

By restricting volume of shoot at main field, highest value of genetic advance was observed for yield per plant (403.68) and least value for seed protein percentage (-3.76).

By restricting weight of root at main field, highest value of genetic

Table 3 : Weighing coefficient values in case of restricted selection indices in AICSMIP genotypes of finger millet genotypes [Eleusine coracana (L.) Gaertn] in *kharif* 2005 and *rabi*l 2006

Character		Days to 50% flowering	Plant height	Productive tillers / plant	Fingers / ear	Finger length	Ear weight / plant	Yield per plant	1000 seed weight	Protein content	Seed calcium	LRM	VRM	VSM	WRM	WSM
Days to 50% flowering	K	0.02	-0.04	-0.01	-0.01	-0.01	-0.02	0.02	-0.07	-0.01	-0.02	-0.01	-0.02	-0.02	0.01	-0.09
	R	0.02	0.03	-0.02	-0.06	0.01	0.02	0.11	0.12	0.02	-0.07	0.07	-0.06	-0.08	-0.03	-0.08
Plant height (cm)	K	0.02	0.02	0.02	0.07	-0.01	-0.01	-0.01	0.08	0.01	-0.03	-0.03	0.01	-0.03	0.02	-0.08
	R	0.01	0.01	0.01	0.01	-0.05	0.04	0.02	0.71	-0.02	-0.86	-0.01	-0.04	0.62	0.06	-0.03
Productive tillers/plant	K	-0.03	0.07	0.21	-0.05	0.62	0.04	0.03	-0.06	-0.08	-0.08	0.23	-0.02	0.07	-0.02	0.07
	R	-0.07	-0.06	0.01	-0.02	-0.04	-0.33	0.18	0.42	-0.26	-0.42	-0.11	-0.54	-0.17	-0.04	-0.01
Fingers/ear	K	-0.02	0.06	-0.07	0.06	0.51	0.03	0.06	-0.03	-0.04	-0.06	0.01	-0.06	0.01	-0.01	-0.07
	R	-0.03	-0.04	-0.09	0.02	0.02	-0.90	-0.16	0.19	-0.11	0.03	-0.05	0.22	-0.08	-0.02	-0.03
Finger length (cm)	K	-0.06	-0.01	0.03	0.35	0.07	0.46	0.19	0.39	0.02	0.07	0.02	-0.07	0.02	0.02	-0.01
	R	-0.01	-0.08	-0.03	-0.04	0.02	-0.04	-0.02	-0.21	-0.09	0.05	-0.02	0.31	-0.03	-0.05	-0.08
Ear weight/plant (g)	K	-0.04	-0.02	-0.01	-0.06	-0.04	-0.01	0.10	-0.05	-0.02	-0.03	-0.01	0.01	-0.02	-0.06	-0.09
	R	-0.06	-0.03	-0.02	0.01	-0.02	0.05	-0.04	-0.12	-0.01	-0.72	0.01	-0.02	-0.06	-0.02	0.06
Yield/plant (g)	K	-0.61	-0.01	0.63	0.07	0.02	0.07	0.09	0.01	0.04	-0.05	0.01	-0.02	-0.06	0.01	-0.03
	R	-0.05	-0.04	0.01	-0.06	0.16	-0.14	-0.42	-0.12	0.03	-0.68	0.13	-0.94	-0.08	0.07	-0.05
1000 seed weight (g)	K	0.02	0.03	-0.01	0.14	-0.04	-0.02	-0.05	0.26	0.05	0.05	0.04	-0.05	0.11	0.06	-0.01
	R	0.07	-0.03	0.02	0.05	-0.15	-0.93	-0.38	-0.49	0.07	-0.03	-0.03	0.03	-0.41	-0.08	-0.03
Protein content (%)	K	-0.03	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02	-0.04	0.21	-0.03	-0.01	0.12	-0.03	-0.02	-0.04
	R	0.07	-0.02	-0.03	-0.02	0.08	0.23	0.11	0.08	-0.17	-0.07	0.02	-0.02	0.07	0.18	-0.07
Seed calcium (mg/100g)	K	-0.06	-0.05	0.08	-0.03	0.21	-0.02	-0.16	-0.01	-0.04	-0.03	0.12	-0.01	0.09	0.05	-0.08
	R	-0.08	-0.04	0.47	0.01	-0.13	-0.01	-0.15	0.06	0.12	-0.05	-0.03	-0.05	-0.52	-0.04	-0.02
LRM (cm)	K	-0.01	0.07	0.01	0.03	-0.04	-0.03	-0.87	0.03	0.54	-0.06	0.03	0.08	-0.04	-0.04	-0.06
	R	-0.04	0.06	-0.01	-0.03	0.16	-0.11	-0.39	-0.03	-0.02	-0.03	0.04	-0.03	-0.71	0.03	-0.05
VRM (cc)	K	0.03	-0.01	-0.02	-0.03	-0.02	-0.01	-0.22	-0.03	-0.65	-0.04	-0.01	0.14	-0.01	0.12	-0.04
	R	-0.03	-0.07	0.21	0.01	0.12	-0.16	-0.87	-0.87	-0.04	-0.08	0.02	0.32	-0.09	-0.16	-0.08
VSM (cc)	K	-0.01	-0.02	0.31	0.03	0.21	-0.05	-0.43	0.44	0.46	-0.08	-0.06	0.01	-0.07	-0.03	0.01
	R	-0.06	-0.04	-0.01	-0.01	-0.11	-0.12	-0.62	0.41	0.06	-0.04	-0.01	-0.03	0.06	0.05	-0.07
WRM (g)	K	-0.06	-0.01	-0.02	-0.03	-0.01	-0.06	0.21	-0.22	-0.33	-0.01	-0.03	-0.01	-0.01	-0.15	-0.01
	R	-0.07	-0.01	-0.01	-0.06	-0.03	-0.02	-0.45	-0.05	0.17	-0.02	0.01	-0.03	-0.83	-0.86	-0.03
WSM (g)	K	-0.05	-0.01	0.23	0.26	0.01	-0.04	0.32	0.65	0.86	-0.02	-0.05	0.13	0.01	-0.07	-0.02
	R	-0.05	-0.02	0.22	-0.08	-0.06	-0.13	-0.82	-0.07	0.23	-0.06	0.02	-0.06	-0.01	0.07	-0.06

L = Length, V = volume, W = weight, R = root, S = shoot, M = main field, K= Kharif, R= Rabi.

advance was observed for seed protein percentage (412.42) and least value for fingers per ear (-1.59). By restricting weight of shoot at main field, highest value of genetic advance was observed for 1000 seed weight (130.51) and least value for volume of root at main field (-1.74).

Table 4 : Genetic advance (Gi) values in case of restricted selection indices in AICSMIP genotypes of finger millet genotypes (Eleusine coracana (L.) in *kharif* 2005 and *rabi* 2006.

Character		Days to 50% flowering	Plant height	Productive tillers / plant.	Fingers / ear	Finger length	Ear weight / plant	Yield per plant	1000 seed weight	Protein content	Seed calcium	LRM	VRM	VSM	WRM	WSM
Days to 50% flowering	K	-0.61	5.44	1.29	-3.87	0.99	2.87	2.42	22.93	1.07	-0.38	4.96	-0.88	1.31	3.93	0.69
	R	-0.26	3.69	23.16	2.16	0.75	1.67	1.69	9.83	19.47	0.29	2.69	-1.79	-17.23	3.49	9.58
Plant height (cm)	K	3.16	-0.21	94.96	5.69	-0.81	0.81	10.52	14.75	86.58	1.16	1.82	22.07	2.79	1.97	85.35
	R	4.34	-0.05	230.18	1.73	1.46	1.89	11.81	1.13	15.74	99.84	1.36	160.81	3.97	2.83	110.49
Productive tillers/plant	K	6.29	9.88	-0.14	4.64	1.84	-0.07	-6.17	1.17	26.71	278.37	1.73	0.82	1.48	1.34	2.37
	R	0.71	3.65	-0.49	1.51	3.07	1.04	1.09	1.08	1.06	24.65	-2.41	2.34	-1.72	0.82	3.39
Fingers/ear	K	-0.15	1.31	6.29	-0.72	0.01	-0.07	0.02	1.76	-1.13	-1.88	2.82	0.13	0.11	-1.59	-0.74
	R	2.03	4.44	1.12	-0.67	1.29	2.03	0.81	0.79	2.73	4.39	8.77	1.62	-6.12	0.96	0.02
Finger length (cm)	K	-0.06	10.19	1.30	1.24	-0.88	0.27	-0.15	2.31	0.81	-1.02	2.76	-96.03	-1.07	1.05	23.04
	R	2.76	1.41	-0.21	2.73	-0.61	1.29	2.57	2.83	7.34	2.08	-7.78	-49.61	3.46	-1.02	-23.97
Ear weight/plant (g)	K	-0.73	1.05	-2.35	-0.92	-3.06	-0.02	10.56	2.17	1.19	41.35	-3.49	29.88	346.99	1.06	1.82
	R	3.08	2.16	-7.03	-1.62	2.31	-0.03	11.45	3.61	0.11	1.09	6.09	402.54	67.11	1.06	-2.36
Yield/plant (g)	K	-3.32	2.28	1.22	21.63	1.02	-2.87	-0.02	1.81	1.12	-1.67	3.88	19.21	403.68	74.91	0.48
	R	-5.18	-2.11	2.24	22.77	-5.23	2.01	-0.09	2.67	0.04	2.53	6.14	6.65	66.45	60.51	0.87
1000 seed weight (g)	K	1.76	7.19	-67.11	-18.12	8.39	13.49	8.13	-0.01	86.66	278.61	3.88	-15.89	347.02	74.89	130.51
	R	1.26	10.54	-126.81	-19.59	1.05	298.97	10.68	-0.09	0.62	99.54	8.82	-49.84	75.12	60.66	151.02
Protein content (%)	K	199.87	5.89	8.86	259.64	-9.54	125.32	54.68	-22.82	-0.12	-7.2	2.75	5.14	-3.76	412.42	2.23
	R	241.49	7.18	9.46	218.11	33.84	228.38	99.21	44.27	-0.02	-1.32	-1.32	3.11	13.03	2.37	-6.69
Seed calcium (mg/100g)	K	1.75	6.29	6.13	-0.89	-3.61	117.23	8.02	167.93	1.78	-0.67	4.95	1.82	1.12	-0.06	1.81
	R	1.25	7.67	-1.91	1.39	172.62	202.51	1.68	4.79	19.47	-0.03	-1.81	158.71	2.34	1.34	2.37
L.R.M (cm)	K	1.26	7.19	9.09	-1.32	9.18	-1.99	6.31	167.23	2.13	2.18	-0.14	22.68	1.49	-0.60	23.04
	R	3.32	10.51	10.21	218.09	2.69	9.97	2.39	1.31	167.65	1.06	-0.42	-1.22	-1.73	1.62	23.96
V.R.M (cc)	K	-3.30	-5.75	-67.01	259.63	-3.61	-1.99	89.01	3.12	11.77	-5.03	16.64	-0.71	2.93	1.90	-1.74
	R	-5.16	-6.75	127.11	-19.83	3.03	-2.09	99.65	-2.61	-0.18	18.98	2.66	-0.02	-1.01	1.89	3.92
V.S.M (cc)	K	-1.05	0.29	-0.76-	-18.17	-9.62	7.11	0.32	0.68	3.43	-7.71	-1.21	-0.48	-0.10	3.90	2.39
	R	3.12	-2.13	1.89	6.72	175.03	-2.10	10.17	-3.71	0.19	6.48	14.45	5.24	-0.96	3.87	3.89
W.R.M (g)	K	-2.17	0.61	1.22	-1.05	8.43	117.3	8.03	0.28	3.45	13.7	1.62	0.71	10.99	-0.42	85.54
	R	2.18	-2.01	2.16	1.73	33.46	200.23	7.36	-2.68	0.56	6.45	1.41	1.62	9.53	-0.06	110.76
W.S.M (g)	K	-1.13	0.19	-2.33	21.81	11.87	125.33	54.84	-2.16	11.75	-8.21	1.66	16.41	1.02	24.3	-0.67
	R	2.17	-2.41	6.97	22.85	23.63	228.61	90.79	1.82	-0.17	18.98	1.38	102.43	3.36	19.79	-0.03

L = Length, V = volume, W = weight, R = root, S = shoot, M = main field, K = Kharif, R= Rabi.

AICSMIP *rabi* 2006 genotypes

By restricting days to 50% flowering, highest value of genetic advance was observed for seed protein percentage (241.49) and least value for yield per plant (-5.18) and volume of root at main field (-5.16). By restricting plant height, highest value of genetic advance was observed for 1000 seed weight (10.54) and length of root at main field (10.51) and least value for volume of root at main field (-6.75).

By restricting productive tillers per plant, highest value of genetic advance was observed for plant height (230.18) and least value for 1000 seed weight (-126.81). By restricting fingers per ear, highest value of genetic advance was observed for seed protein percentage (218.11) and least value for volume of root at main field (-19.83).

By restricting length of finger, highest value of genetic advance was observed for volume of shoot at main field (175.03) and least value for yield per plant (-5.23). By restricting ear weight per plant, highest value of genetic advance was observed for weight of shoot at main field (228.61) and least value for volume of shoot at main field (-2.10).

By restricting yield per plant, highest value of genetic advance was observed for volume of root at main field (99.65) and least value for plant height (-11.81). By restricting 1000 seed weight, highest value of genetic advance was observed for seed protein percentage (44.27) and least value for volume of shoot at main field (-3.77).

By restricting seed protein percentage, highest value of genetic advance was observed for length of root at main field (167.65) and least value for volume of root at main field (-0.18).By restricting seed calcium content, highest value of genetic advance was observed for plant height (99.84) and least value for seed protein percentage (-1.32).

By restricting length of root at main field, highest value of genetic advance was observed for volume of shoot at main field (14.45) and least value for length of finger (-7.78). By restricting volume of root at main field, highest value of genetic advance was observed for ear weight per plant (402.54) and least value for length of finger (-49.61).

By restricting volume of shoot at main field, highest value of genetic advance was observed for ear weight per plant (67.11) and least value for days to 50% flowering (-17.23). By restricting weight of root at main field, highest value of genetic advance was observed for 1000 seed weight (60.66) and least value for length of finger (-1.02). By restricting weight of shoot at main field, highest value of genetic advance was observed for 100 seed weight (151.02) and least value for seed protein percentage (-6.69).

The characterwise addition resulted in increase of genetic advance values dring both seasons. Addition from 7 to 9 characters showed substantial increase in genetic advance values during both seasons indicating utility of multiple selection criteria over straight selection. The higher relative efficiency values over protein percentage during kharif and over yield per lant during rabi point out the seasonal impact on selection. While the relative efficiency over 1000 seed weight remained relatively constant over two seasons.

In case of restiction selection indices the maximum genetic advance values were observed for protein percent by restricting days to 50% flowering (K 199.87 R 241.49), fingers/ear (K 259.64, R 218.11) ear weight per plant (K 125.32, R 228.38),yield per plant (K 54.18, R 99.21) WRM (g) (K 412.42, R 2.37) . Similarly high gain was obtained in seed calcium while restricting ear weight per plant (K 117.23, R 202.51). There was also high value of genetic advance for yield per plant (g) by restricting VSM (K 403.68 ,R 466.45) and WRM ((K 74.91 and 60.51). Like that high advances in 1000 seed weight by restricting protein percentage (K 86.66, R 0.62) seed calcium (278.61, 99.54), VSM (347.02,75.12) WRM (K74.89, R 60.66) and WSM (K 130.51, R51.02). These results bring out the successful cases of restriction of these characters for substantial gain in protein, seed calcium, yield per plant and 1000 seed weight in finger millet.

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Heterosis for Seedling and Field Characters in Rice

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ABSTRACT

This experiment involving 5 lines, 3 testers and 15 crosses indicated significant relative heterosis and heterobeltiosis values for several root and shoot characters in nursery and tiller number and panicle length in field in rice hybrids. The lines BOA, Zhen Shan 97A, UIA, Jin 23A and testers Ming Hui 63, T D 366 resulted in good hybrids when crossed, as also indicated by combining ability values and may be utilized in hybrid rice breeding programmes.

Key words : Heterosis, Rice, Hybrid Rice

Initial vigorous performance of hybrids puts them ahed of race in beating the conventional rice varieties in character expression (Deng Dingwu and Tan Zhijun, 1993). In India hybrid rice is making considerable progress in recent years. Therefore, this investigation was taken up to know the combining ability and heterosis of seedling and field characters in crosses of rice.

MATERIAL AND METHODS

The material consisted of 5 cytoplasmic male sterile lines (V2OA, Zhen Shan 97A, BOA, UIA and Jin 23A as females), three restorer lines (Ming Hui 63 (MH 63), TD366 and TD 368 as males) and the 15 hybrids resulting from crossing them in Changsha in line and tester fashion as per Kempthorne, 1957. The 23 treatments {15 hybrids and 8 patents (5 B lines + 3 R lines) } were sown in randomized block design with two replications at Sanya the tip of Hainan island of Southern China. Each entry had 200 seedlings per replication. Clean plant samples from nursery were collected using a digging plate and washing the roots free of soil in water. Observations on 5 seedlings for replication were recorded on length (cm), volume (CC) by water displacement in burette and weight (g) of root and shoot portions on 20th and 30th day of nursery.

The 30 day old seedlings with transplanted in 2 rows of 4m length in randomized block design in 3 replications following inter- and intra-row spacing of 30x15 cm. Recommended package of practices was followed. Observations were recorded on plant height (cm) during vegetative and flowing stages, total tillers, ear bearing tillers and panicle length on 5 plants per replication per genotype.

The data were analyzed following Kempthorne (1957) and relative heterosis and heterobeltiosis were estimated as per Liang *et al.* (1952).

RESULTS AND DISCUSSION

The Analysis of variance indicated significant gtreatment differences for all the characters (Fig 1 to 6) except shoot dry weight at 20 days. The differences among parents were significant for all characters except root volume and weight at 20 days, shoot volume at 20 days shoot weight at 30 days and total tillers.

The parents and crosses interaction was significant for root length at 30 days, root volume at 20 and 30 days, shoot volume at 20 and 30 days, root dry weight at 30 days shoot dry weight 30 days, total tillers, platn height at flowering, ear bearing tillers, and panicle length indicating different behaviour of parents and crosses. The crosses component was significant for all characters (except root length at 20 days and shoot volume at 20 days) indicating differences among the crosses.

The differences among lines were significnat for shoot length at 20 days, plant height at vegetative stage and panicle length indicating additive gene control of these traits. The testers component was significant for shoot length at 20 days and 30 days, Plant height at vegetative stage as flowering EBT and panicle length indicating additive control of these traits. The line and tester interaction was significant for root length at 30 days shoot length at 30 days, root volume at 20 and 30 days, shoot vloume at 30 days, root dry weight at 20 and 30 days ashoot volume at 30 days, root dry weight at 20 and 30 days and shoot dry weight at 30 days, plant height at vegetative and flowering stages indicate dominant gene control of these traits.

Table 1 : Analysis of variance for seedling and field characters in rice.

Source	df	Mean squares																
		Length				Volume				Weight								
		Root 20 DAS	Root 30 DAS	Shoot 20 DAS	Shoot 30 DAS	Root 20 DAS	Root 30 DAS	Shoot 20 DAS	Shoot 30 DAS	Root 20 DAS	Root 30 DAS	Shoot 20 DAS	Shoot 30 DAS	Plant height	Total tillers	Plant height at floweirng	EBT/ plant	Panicle length
Replications	1(2)	0.340	0.0008	0.970	1.54	0.0002	0.30	0.0019	0.05	0.00000	0.0000	0.0000	0.000	4.28	4.93	83.49*	9.02	1.52
Treatments	22(44)	1.006*	5.06**	3.350**	8.60**	0.0206**	0.83**	0.0146**	2.49**	0.00019**	0.0040**	0.0002	0.020**	66.97**	22.00*	209.97**	8.16**	12.14**
Parents	7(7)	1.990*	5.93**	3.950**	7.07	0.0049	0.27**	0.0071	0.43**	0.00008	0.0500**	-	0.001	130.38**	3.21	234.41**	10.18**	18.41**
PvsC	1(1)	0.010	7.87*	0.226	0.05	0.1021**	9.41**	0.1746**	29.7**	0.00022	0.0500**	-	0.220**	31.01	313.54**	1011.98**	25.39**	48.86**
Crosses	14(14)	0.586	4.46**	3.283**	9.98**	0.0226**	0.50*	0.0070	1.57**	0.00024**	0.0100**	-	0.006*	37.83**	10.58*	140.47**	5.92**	6.38**
Lines	4(4)	-	5.97	3.404*	3.27	0.0377	0.29	-	2.70	0.00034	0.0007	-	0.008	83.52**	16.23	58.91	6.98	2.67**
Testers	2(2)	-	0.79	13.012**	44.12**	0.0192	0.785	-	1.92	0.00014	0.0003	-	0.007	81.78**	2.03	736.07**	15.66**	36.75**
LXT	8(8)	-	4.57**	0.790	4.67	0.0160*	0.54**	-	0.92**	0.00022**	0.1600	-	0.010*	4.00**	9.89	32.34**	2.96	0.64
Error	22(44)	0.399	1.04	0.473	1.20	0.0051	0.09	0.0050	0.10	0.00005	0.0004	-0.0001	0.003	8.87	4.79	12.50	2.22	0.63

DAS = Days after sowing df = Degrees of freedom, df in parentheses for field characters.

The GCA ans SCA estimates are presented in Table 2 and heterosis effects in Table 3. For root length ZS97B(0,18 at DAS and 0.96 at 30 DAS) for shoot length V2OB (0,93 at 20 DAS) and Jin 23B (0,53 at 20 DAS and 0,70 at 30 DAS) showed good GCA effects. While for root and shoot volume at 30 DAS (0,36 and 1.25, respectively) and weigfht at 30 DAS (0.40 and 0.083) BOB showed high GCA effects. For plant height Jin23B (4.33 at vegetative and 4.18 at flowering) showed high GCA effects. For total tillers (1.30) and ear bearing tilers (0.75) BOB showed high GCA effect and ZS97B(0.57) and Jin 23B showed good GCA effect for panicle length.

Among the testers MH63 showed good combining ability for root length at 20 DAS (0.020), root volume at 20 DAS (0.052), root weight at 20 DAS (0.003) and 30 DAS (0.014), shoot weight at 20 DAS (0.008) and panicle length (1.72). While TD 366 expresses good combining ability for shoot length at 20 DAS (1.36) and 30 DAS(2.44), root volume at 30 DAS (0.25), shoot volume at 20 DAS (0.026) and 30 DAS (0.20), plant height at vegetative (2.16) and flowering stages (7.66) and ear bearing tillers (0.72). The tester TD 368 expressed good gca effects for root length at 30 DAS (0.20), shoot weight at 30 DAS (0.015).

Among crosses UIA/TD 366 for root length at 20 DAS (19.80*,18.40*), ZS97A, TD 366 for root length at 30 DAS (27.60* and 23.60*), V 20A/ TD 366 for shoot length at 30 DAS (18.39* and 16.60) expressed significant relative heterosis and heterobiltiosis. While crosses UIA/MH63 (88.6* and 72.9*) followed by UIA/TD 366 (66.6* and 50.0) expressed heterosis for root volume at 20 DAS. For shoot volume at 30 DAS crosses BOA/TD 366 (133.30** and 110.00) followed by crosses ZS97A/TD366 (130.18** and 103.30**) and ZS97A/MH63 (106.34** and 62.50**) showed significant heterosis values.

For shoot volume at 30 DAS crosses BOA/ MH63 (182.35 and 155.36**) and BOA/TD 366 (214.28 and 189.40**) showed significnat heterosis. Similarly BOA/MH63 (92.00 and 41.17** for root dry weight at 30 DAS and 122.70 and 104.00** for shoot dry weight at 30 DAS) followed BO A/TD 366 (100.00 and 61.50** for root dry weight at 30 DAS and 105.00 and 105.00** for shoot dry weight at 30 DAS expressed heterosis for root and shoot dry weight.

Similarly crosses ZS 97A/MH63 (51.56* and 48.09*) and BOA/TD 368 (57.14 and 57.14**)and Jin 23A / TD 366 (56.05 and 50.00**) expressed heterosis for total tillers. While ZS97A/TD 366 expressed heterosis for EBT (32.16* and 21.50).

Table 2 : GCA and SCA values for seedling and field characters in rice.

Parents/ crosses	Length				Volume				Weight			Plant height	Total tillers	Plant height at floweirng	EBT/ Plant	Panicle length
	Root		Shoot		Root		Shoot		Root		Shoot					
	20 DAS	30 DAS	20 DAS	30 DAS	20 DAS	30 DAS	20 DAS	30 DAS	20 DAS	30 DAS	30 DAS					
Lines																
V20B	0.08	0.92	0.93	0.26	0.060	-0.09	0.010	-0.23	0.001	0.010	-0.007	1.26	0.30	-0.88	0.98	-0.41
ZS97B	0.18	0.96	-0.40	-1.10	0.020	-0.10	0.010	-0.18	0.004	0.010	0.013	-2.63	0.96	-0.09	-0.34	0.57
BOB	0.03	0.01	-0.95	-0.34	-0.080	0.36	-0.040	1.25	0.004	0.040	0.083	-3.06	1.30	-2.78	0.75	-0.10
UIB	0.19	-1.55	-0.10	0.50	0.090	0.07	0.070	0.22	0.000	-0.010	-0.007	0.10	-1.90	-0.42	-1.21	-0.60
Jin 23B	-0.48	-0.34	0.53	0.70	-0.090	-0.21	-0.050	-1.06	-0.009	-0.050	-0.082	4.33	-0.76	4.18	-0.18	0.54
Testers																
MH 63	0.20	0.14	-0.52	0.92	0.052	0.17	-0.008	0.07	0.003	0.014	-0.006	0.32	-0.42	-1.60	-1.16	1.72
TD 366	-0.17	-0.34	1.36	2.44	-0.004	0.25	0.026	0.20	-0.002	-0.016	-0.009	2.16	0.26	7.66	0.72	-0.42
TD 368	-0.03	0.20	-0.84	-1.52	-0.048	-0.42	-0.018	-0.27	-0.001	0.002	0.015	-2.48	0.16	-6.06	0.44	-1.30
Crosses																
V20A/MH 63	0.22	-1.22	-0.02	-1.54	-0.002	-0.97	-0.052	-1.15	0.002	-0.044	-0.115	-0.58	0.12	1.97	0.50	0.64
V20A/TD 366	0.32	-0.72	0.06	1.50	0.004	0.45	0.042	0.67	-0.003	0.036	0.099	0.98	-0.66	-1.79	-1.18	-0.61
V20A/TD 368	-0.54	1.94	-0.04	0.04	-0.002	0.52	0.010	0.47	0.001	0.008	0.025	-0.38	0.54	-0.17	0.70	-0.03
ZS97A/MH 63	-0.50	-1.14	-0.18	0.92	-0.062	0.60	0.048	0.05	-0.025	0.006	0.015	0.30	2.62	-4.13	0.36	0.08
ZS97A/TD 366	-0.28	1.54	-0.26	-1.44	-0.006	0.32	0.014	-0.08	0.017	0.016	0.079	-0.32	-0.18	3.80	-0.22	0.09
ZS97A/TD 368	0.78	-0.40	0.44	0.52	0.068	-0.92	-0.052	0.03	0.008	-0.022	-0.075	0.02	-2.46	0.33	-0.14	-0.18
BOA/MH63	0.06	-0.34	0.26	1.76	-0.002	-0.02	0.028	0.83	0.001	0.006	0.075	0.40	-0.48	1.60	0.83	0.22
BOA/TD 366	-0.52	0.94	-0.36	-1.00	-0.046	-0.05	-0.038	0.18	-0.003	0.006	-0.001	-1.52	-0.46	-1.36	-0.75	0.14
BOA/TD368	0.46	-0.60	0.09	-0.76	0.048	0.07	0.100	-1.01	0.002	-0.0112	0.075	1.12	0.94	-0.24	-0.07	-0.36
UIA/MH 63	-0.08	0.86	0.56	0.62	0.098	0.45	-0.032	0.13	0.018	0.072	0.125	0.78	0.62	-3.70	-0.42	-0.48
UIA/TD 366	0.77	-1.16	0.64	-0.64	0.074	-0.48	0.002	0.22	0.010	-0.054	-0.134	-0.96	0.64	1.24	0.92	0.26
UIA/TD368	-0.69	0.30	-1.20	0.02	-0.162	0.04	0.030	-0.35	0.008	-0.018	0.010	0.18	-1.26	2.46	-0.50	0.22
Jin 23A/MH 63	0.30	1.83	-0.62	-1.78	-0.052	-0.05	0.008	0.13	0.002	-0.054	-0.759	-0.85	-2.84	2.90	-1.24	-0.42
Jin 23A/TD 366	-0.23	-0.59	-0.09	1.56	-0.046	-0.23	-0.026	-0.10	-0.013	-0.014	-0.031	1.70	1.68	-1.26	1.28	0.12
Jin 23A/TD 368	-0.07	-1.23	0.71	0.22	0.098	0.28	0.018	0.86	0.011	0.068	0.785	-0.85	1.16	-1.64	-0.04	0.30
SE(gca of line)	0.77	1.24	0.84	1.34	0.007	0.36	0.086	0.38	0.008	0.20	0.060	3.64	2.68	4.30	1.82	0.97
CD(P=0.05) gca of line	2.23	3.61	2.45	3.91	0.20	1.05	0.250	1.10	0.023	0.058	0.175	10.62	7.82	12.55	5.31	2.83
SE(gca of line)	0.99	1.61	1.08	1.73	0.112	0.47	0.111	0.05	0.011	0.030	0.080	4.70	3.46	5.59	1.92	1.25
CD (P=0.05) gca of line	2.91	4.70	3.15	5.04	0.326	1.34	0.323	0.14	0.032	0.087	0.233	13.71	10.10	16.31	5.60	3.64
SE(sca of line)	0.44	0.72	0.48	0.77	0.50	0.21	0.050	0.22	0.005	0.014	0.038	2.10	1.54	2.50	1.05	0.56
CD (P=0.05) sca of line	1.30	2.10	1.41	2.24	0.145	0.61	0.145	0.64	0.014	0.040	0.110	3.12	4.51	7.29	3.06	1.63

EBT = Ear bearing filters; DAS = Days after sowing.

Table 3 Relative heterosis (RH) and heterobeltiosis (HB) for seedling and field characters in rice

	Length (cm)								Volume (CC)								Weight (g)					
	Root				Shoot				Root				Shoot				Root				Shoot	
	20 DAS		30 DAS		20 DAS		30 DAS		20 DAS		30 DAS		20 DAS		30 DAS		20 DAS		30 DAS		30 DAS	
	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB	RH	HB
V20A/ MH 63	8.70	8.30	-7.75	-11.02	-6.90	2.56	-8.08	-10.00	32.07	20.68	-15.00	-15.00	4.34	0.00	0.99	5.50	40.00	\27.27	-5.50	-10.50	-10.60	12.50
V20A/ TD 366	9.00	5.00	-4.64	11.02	8.98	0.35	18.39*	16.60	20.37	12.06	82.80**	60.00	32.72	21.66	143.24	66.60**	26.30	20.00	37.50	15.78	95.34	82.60**
V20A/ TD 368	7.40	9.48	1.04	14.17	-4.50	-8.26	-1.31	-5.80	9.09	3.44	30.00	30.00	26.20	8.33	60.40	42.50*	30.00	18.18	13.50	1052	68.18	60.86**
ZS97A / MH63	6.09	-10.80	3.16	-3.30	-1.40	-2.32	0.44	-1.30	22.44	20.00	106.34**	62.50**	23.80	20.60	70.78	61.70**	0.01	-9.09	75.00	28.52	56.52	50.00**
ZS97A /TD 366	-4.80	-12.90	27.60*	23.60*	0.61	-11.50	4.17	1.71	20.00	20.00	130.18**	103.30**	29.60	20.60	76.74	80.95*	36.84	30.00	90.00	46.15**	100.00	90.90**
ZS97A /TD 368	7.00	3.40	-7.20	-23.75	-7.09	-14.90	-1.36	-2.25	22.33	18.86	-2.69	-42.50	18.81	39.50	64.28	4.28	10.00	0.00	44.00	0.01	34.80	31.80
BOA / MH63	7.60	-17.70	-9.30	-13.17	-0.95	-3.20	7.04	5.65	20.83	20.83	93.75**	55.00	16.66	14.54	182.35	155.30**	4.76	0.00	92.00	41.17	122.70	104.00**
BOA / TD 366	-17.50	-28.99	0.41	-6.90	-3.50	-16.18	8.97	6.86	-2.04	-4.00	133.30**	110.00**	16.50	13.20	214.28	189.40**	-10.00	-10.00	100.00	61.50**	105.00	105.00**
BOA / TD 368	6.50	-15.38	-23.80	-31.25	-13.72	-22.04	-4.07	5.35	4.95	0.01	62.50	30.00	25.00	13.20	92.50	83.30	-4.76	-9.00	69.20	22.20	75.60	71.40**
UIA /MH63	-8.90	6.00	-7.62	-7.62	7.94	7.44	-0.41	-4.76	88.60	72.9	54.76**	47.72**	36.00	23.60	66.90	53.50	46.50*	27.27	67.74	52.94**	76.47	66.60
UIA /TD 366	19.80*	18.40*	-26.30	-28.80	9.97	-2.84	7.62	3.57	66.60	50.00*	29.72	9.09	57.80	50.00**	104.50	60.70	33.30	20.00	-25.90	-28.50	-19.14	-29.60
UIA /TD 368	-5.30	-9.40	-25.17	-35.00	-18.81	-25.50	-2.97	-9.52	3.22	-9.40	7.14	2.27	70.45	66.66**	42.80	25.00	-16.20	-27.20	6.25	-5.50	50.00	33.30
Jin 23A / MH 63	10.70	1.50	7.81	4.80	-8.52	-17.29	-13.14	-19.85	2.04	0.01	-25.00	25.00	14.28	9.09	14.28	3.44	-13.04	-16.60	-40.00	-4.70	-38.70	-40.00
Jin 23A /TD 366	0.10	-4.90	-13.19	-18.40	-1.47	-3.59	12.87	4.77	-10.00	-10.00	37.14*	20.00	20.00	20.00	-11.10	-31.00	-45.45	-50.00	-2.30	-23.00	-11.11	-20.00
Jin 23A /TD 368	-0.40	-10.20	-29.12	-36.87	-7.69	-9.77	-5.30	-14.70	6.79	3.77	12.50	12.50	29.03	20.00	40.00	20.60	-4.34	-8.33	35.48	16.60	65.21	52.00**
Standard error	0.54	0.63	0.88	1.01	0.59	0.68	0.94	1.09	0.06	0.07	0.25	0.30	0.06	0.07	0.075	0.31	0.01	0.01	0.02	0.028	0.04	0.05

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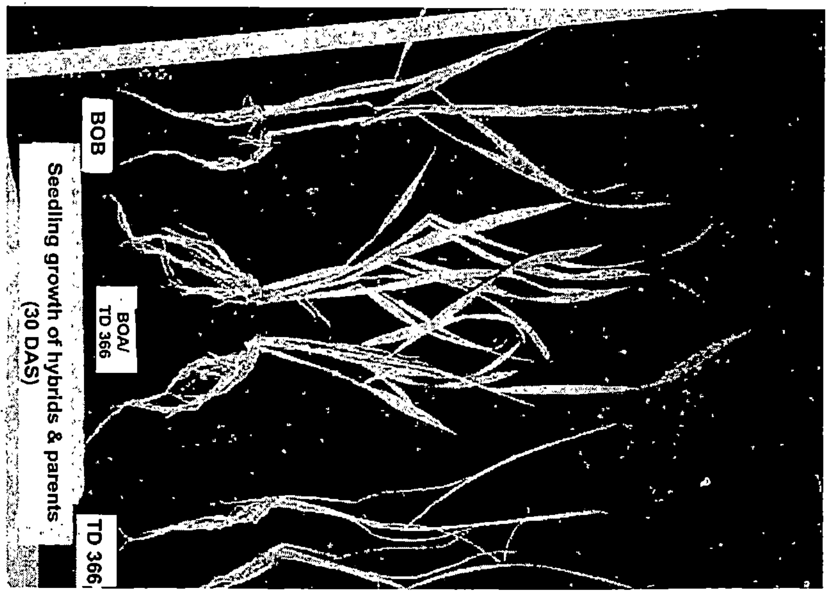

Fig 1:Heterosis for seedling growth in rice BOB (left), BOA/TD 366(center),TD 366 (right)

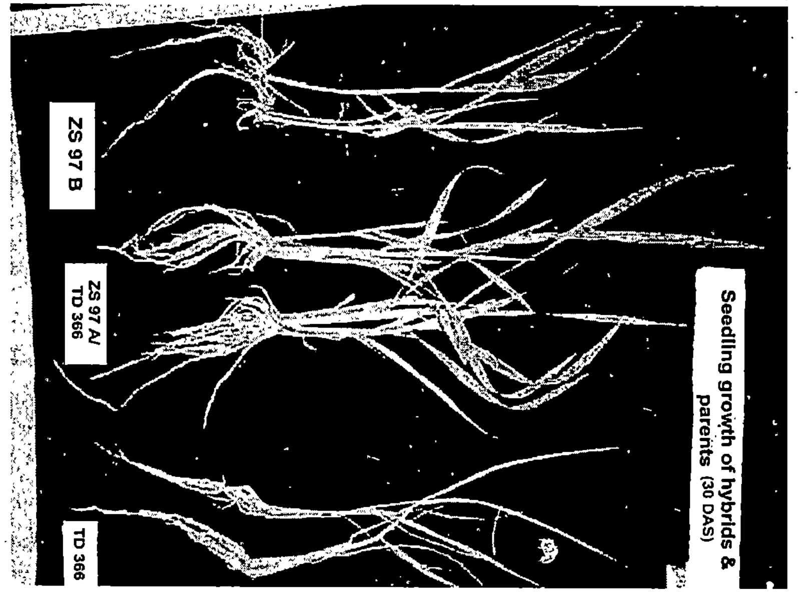

Fig 2: Heterosis for seedling growth in rice ZS 97B (left), ZS 97 A/TD 366(center),TD 366(right)

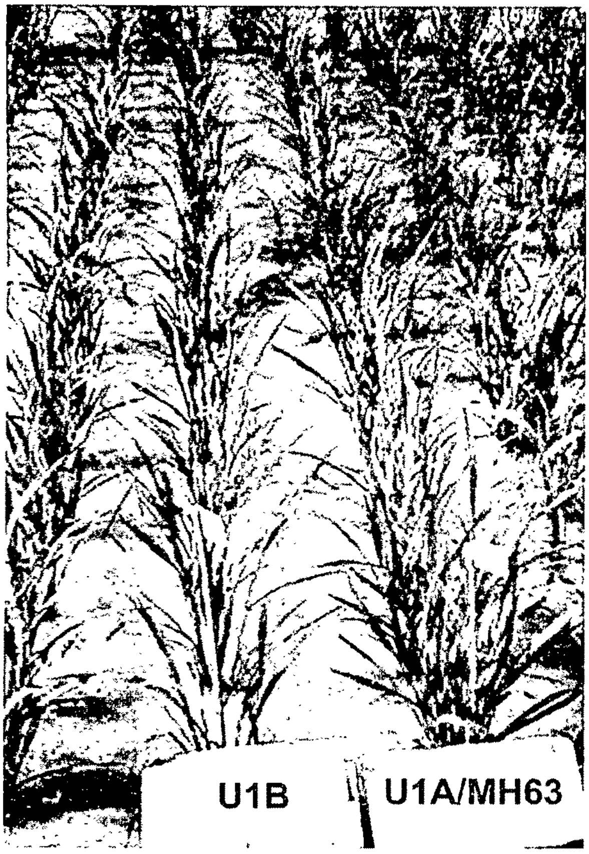

Fig 3:Heterosis for vegetative growth in rice U1B (left), U1A/Ming Hui 63(right)

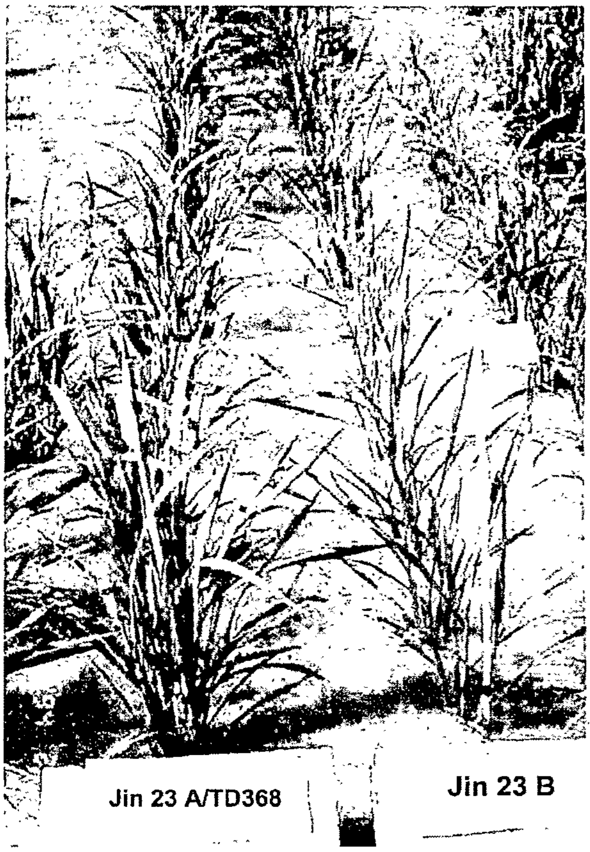

Fig 4:Heterosis for vegetative growth in rice Jin 23A/TD368(left), Jin 23 B (right)

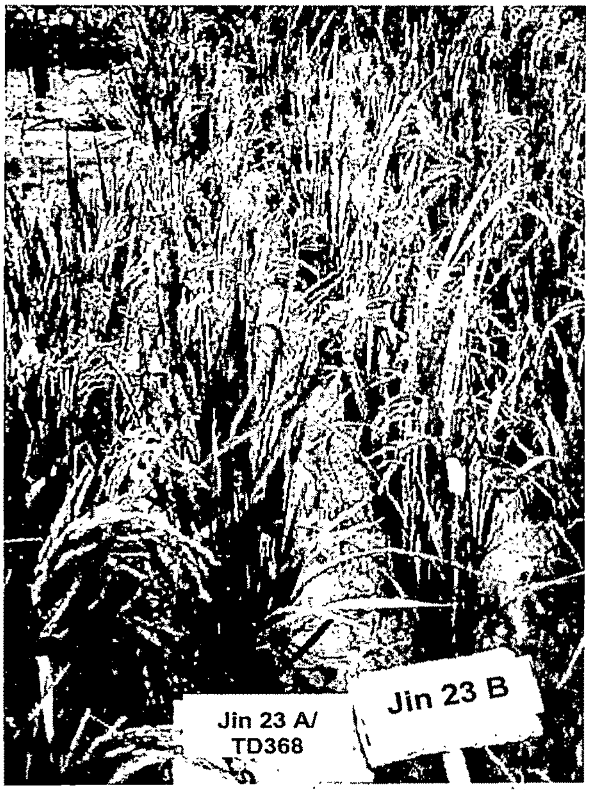

Fig 5:Heterosis for reproductive characters in rice Jin 23 A/TD368 (left), Jin 23 B(right)

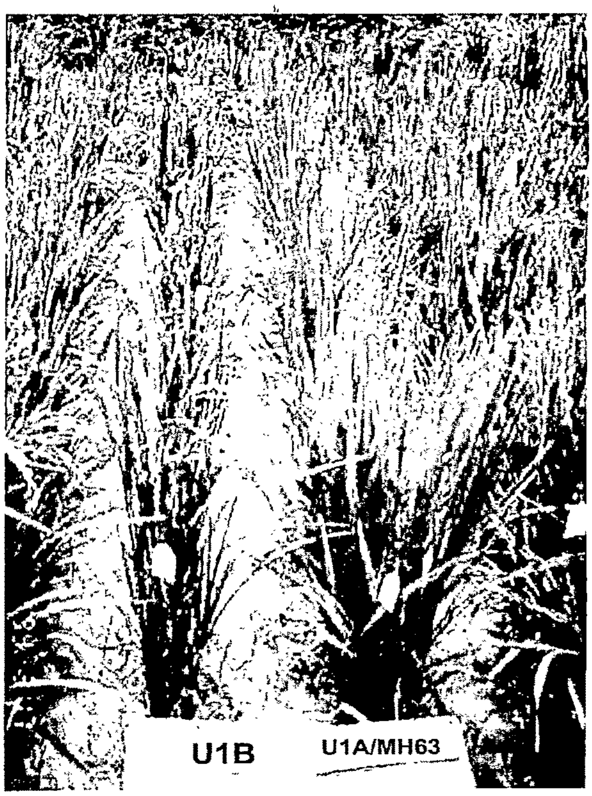

Fig 6:Heterosis for reproductive characters in rice U1B (left), U1A / Ming Hui 63 (right)

Table 3 contd.,

Plant height		Total tillers		Plant height at flowering		EBT/ plant		Panicle length	
RH	HB	RH	HB	RH	HB	RH	HB	RH	HB
6.25	-3.98	30.40	30.40	11.90	-3.20	1.32	-12.20	19.12	-1.60
3.72	1.66	39.60	29.60	23.60	9.62	23.80	21.87	10.99	-3.19
3.30	-8.30	41.80	38.40	3.84	-9.78	22.50	9.90	9.13	-0.05
4.60	-2.30	51.56*	48.09**	-6.80	-9.50	4.30	-23.60	9.60	0.01
-1.60	-3.11	36.97	24.42	17.55	17.40	32.16*	21.50	7.76	4.56
0.68	-7.80	27.20	21.30	-6.16	-8.20	12.56	-7.43	2.34	0.90
7.17	2.60	36.80	33.60	4.83	-4.35	4.03	-11.45	5.37	-2.00
-1.89	-5.80	53.98	46.21	14.05	-7.00	28.60	27.95	2.76	1.82
5.80	-1.31	57.14	57.14*	-5.20	-13.00	15.49	1.65	-3.90	-5.00
6.71	-3.49	29.46	160.00**	0.70	-9.40	20.37	-35.80	4.71	-6.80
-1.10	-2.99	47.50	42.05**	21.50	14.00	34.10**	24.70**	5.79	0.01
2.34	-9.15	22.01	11.76	2.27	-6.08	-1.49	-18.18	1.20	-4.50
5.40	-8.60	1.24	2.40	17.13	3.76	25.54	-34.35	7.92	-2.00
4.60	-1.96	56.05	50.00**	28.15	16.60	34.70**	30.00**	8.27	4.56
2.30	-12.8	42.97	41.00**	6.02	-5.40	3.16	-5.78	4.70	0.90
2.57	2.97	1.89	2.18	3.06	3.53	1.29	1.48	0.68	0.79

ZS97A/TD 366 (4.56) and Jin 23A/TD366 (4.56) for panicle length showed high heterobeltiosis values. The expression of haterobeltiosis for different characters observed in the expriment area also indicated by their values and may be utilized in the hybrid rice breeding programme.

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Restriction Selection Indices in Roselle(*Hibiscus sabdariffa* L.)

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ABSTRACT

Fifty genotypes were evaluated for the construction of restricted selection indices in roselle. Restricted selection indices using single case restriction of 50% flowering, plant height, number of internodes, internodal length, basal stem diameter, bark thickness, fibre-wood ratio and fibre length gave highest genetic advance for fibre yield/pot where as the restriction of fibre yield/ plant and fibre yield/plot gave highest genetic advance for plant height.

Key words : Restricted Selection Indices, Roselle

Roselle is a drought resistant crop mainly cultivated for its fibre. Fibre is obtained from the bast region of the stem. The lignified fibre is chiefly used for making ropes, cordages, gunny bags, stacking material, fishnets, floor mats, hessian and carpet backing etc., By adopting innovative breeding techniques the low production and wide variation in fibre yield can be improved.

Direct selection is not effective for quantitatively inherited characters like fibre yield, which have low heritability. Construction of selection indices will be helpful for making selection on several characters.

MATERIAL AND METHODS

The experiment was conducted at Agricultural College Farm, Bapatla during *kharif* 2005 in randomized complete block design, with four replications. Each genotype was sown in three rows with a length of 4 m and inter- and intra-row spacing of 30 x 10 cm in black clay soil. construction of selection indices was as per Kempthorne and Nordskog (1959).

Using single restriction case, in respect of all the ten characters viz., days to 50% flowering, plant height, number of internodes, internodal length, basal stem diameter, bark thickness, fibre-wood ratio, fibre length, fibre yield / plant and fibre yield/ plot restriction selection indices were constructed in the present study and the genetic advance was calculated for each character in each restriction according to Singh and Chaudhary (1977).

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences among the genotypes for all the characters. The character wise weighing coefficinet (b_i) values and genetic advance (G_i) values for *Hibiscus.sabdariffa* L. are embodied in Table 1 and 2, respectively.

By restricting days to 50% flowering highest value of genetic advance was observed fro fibre yield/ plot (216.5357) and low value for fibre - wood ratio (-0.0274). By restricting plant height highest value of genetic advance was observed for fibre yield/plot (138.4791) and low value for basal stem diameter (-0.0215). When the restriction is imposed on number of internodes highest value of genetic advance was observed for fibre yield/ plot (135.2761) and lowest value for basal stem diameter. Highest value fo genetic advance was observed for fibre yield/plot (169.6610) and lowest value for fibre- wood ratio (-0.0053) when the restrictin is imposed on internodal length. When the restriction is imposed on bark thickness highest value of genetic advance was observed for yiel / plot (186.0016) and lowest value for fibre - wood ratio (-0.0319). Highest value of genetic advance was observed for fibre yield / plot (209.9876) and lowest value for internodal length (-0.3307) when the restriction is imposed on fibre - wood ratio. By restricting fibre length highest value of genetic advance was observed for fibre yield / plot (136.6558) and lowest value for internodal length (-0.0168). When the restriction is imposed on fibre yield / plant highest value of genetic advance was observed for plant height (9.8402) and lowest value for fibre - wood ratio (-0.0338). By restricting fibre yield / plot highest value fo genetic advance value was observed for plant height (10.2826) and lowest value for fibre - wood ratio (-0.0286). The genetic advance values for a particular character under restriction was negligible (zero) indicating successful cases of character restriction.

Restricted selection indices using single case restriction of 50% flowering, plant height, number of internodes, internodal length, basal stem diameter, bark thickness, fibre - wood ratio and fibre length gave highest genetic advance for fibre yield / plot where as the restrictionof fibre yield / plant and fibre yield / plot gave highest genetic advance for plant height.

Table 1 : Weighing coefficients (b_i) in case of restricted selection indices in roselle hemp (Hibiscus sabdariffa L.) genotypes.

Characters	Days to 50% flowering	Plant height	No. of internodes	Internodal length	Basal stem diameter	Bark thickness	Fibre wood ratio	Fibre length	Fibre yield / plant	Fibre yield / plot
Days to 50% flowering	-2.8158	0.6115	1.4272	1.1186	1.4080	1.1323	1.0951	0.5275	1.1446	1.0577
Plant height	2.1561	-7.2999	-2.5906	3.6868	1.9054	3.7413	1.8928	-8.0962	1.7178	1.6009
Number of itnernodes	4.0120	-10.1509	-54.0474	-2.3341	1.0487	4.1264	3.9093	-12.5364	2.9116	3.0063
Internodal length	-1.0399	3.9466	19.1059	225.4571	-4.6778	-1.8995	-0.7100	11.8269	0.0516	-0.6364
Basal stem diameter	5.6158	-29.8059	-19.7791	21.0736	-345.6030	-4.3278	5.6362	-30.3210	9.3120	6.5102
Bark thickness	8.1624	-20.0005	44.2923	15.5968	-85.6217	-1053.3560	10.6586	-10.8593	-5.6608	4.2245
Fiobre-wood ratio	0.3080	56.5477	-31.7284	40.8889	18.7087	-1.4383	755.3062	-26.4440	-9.8716	-1.3351
Fibre length	-0.8966	0.3574	2.2440	-3.4412	-1.4522	-2.5499	-0.6606	1.5444	-0.4073	-0.2363
Fibre yield / plant	23.5478	10.4883	5.1019	7.2003	32.1549	37.2464	25.7596	-4.1824	-50.6686	1.7420
Fibre yield / plot	0.8119	0.8925	0.9188	0.9411	0.7491	0.6949	0.7951	1.0050	0.2957	-0.1410

Table 2 : Genetic advance (ΔG_i) in case of single restricted selection indices in roselle hemp (Hibiscus sabdariffa L.) genotypes.

Characters	Days to 50% flowering	Plant height	No. of internodes	Internodal length	Basal stem diameter	Bark thickness	Fibre wood ratio	Fibre length	Fibre yield / plant	Fibre yield / plot
Days to 50% flowering	0.0000	1.4949	2.2416	1.1851	2.3186	1.7313	1.0790	1.4989	2.8799	2.4542
Plant height	14.3276	0.0000	0.9070	7.3435	5.4475	9.9081	12.7413	-0.1653	9.8402	10.2826
Number of itnernodes	2.1985	0.1602	0.0000	0.9845	0.9102	1.5907	1.9728	0.1136	1.2739	1.3427
Internodal length	-0.3793	-0.0305	0.0212	0.0000	-0.2070	-0.3005	-0.3307	-0.0168	-0.2269	-0.2435
Basal stem diameter	0.2850	-0.0215	-0.0052	0.1624	0.0000	0.1295	0.2534	-0.0249	0.1984	0.2076
Bark thickness	0.0696	0.0050	0.0134	0.0457	0.0034	0.0000	0.0702	0.0035	0.0317	0.0397
Fiobre wood ratio	-0.0274	0.0089	0.0030	-0.0053	-0.0114	-0.0319	0.0000	0.0054	-0.0338	-0.0286
Fibre length	13.7193	0.1979	0.9042	6.9551	5.3355	9.4992	12.3618	0.0000	9.1831	9.6544
Fibre yield / plant	1.7914	1.1402	1.1132	1.3989	1.3777	1.5308	1.7391	1.1242	0.0000	0.0022
Fibre yield / plot	216.5357	138.4791	135.2761	169.6610	166.9672	186.0016	209.9876	136.6558	0.9749	0.0000

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Journal
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Effect of Weather Parameters on the Population Dynamics of *Spodoptera litura* (F.) and *Spodoptera exigua* (Hb.) on Onion

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ABSTRACT

A field experiment was carried out during *rabi*, 2003-04 at Yarrabalem Village, Mangalagiri Mandal, Guntur district to study the influence of weather parameters on the population dynamics of *Spodoptera litura* (F.) and *Spodoptera exigua* (Hb.) on onion. The pest activity was observed for ten weeks commencing from the 46th to 3rd standard week with a peak larval density of 23.83 per ten plants during the 52nd standard week with respect to *S. litura* and 21.03 per ten plants during the 1st standard week in the case of *S. exigua*. There was a significant and negative correlation between the larval population of both the pests and the remaining parameters *i.e.*, minimum temperature, morning and evening relative humidity and rainfall exhibited non-significant relationship.

Key words : Weather Parameters, *Spodoptera litura*, *Spodoptera exigua*, Onion

Onion is one of the important vegetable crops grown in India. India ranks first in area under onion and second in production. Out of five insect pests recorded on onion, thrips was reported as an important pest causing appreciable damage. However of late, tobacco caterpillar, *Spodoptera litura* (F.) and lucerne caterpillar, *Spodoptera exigua* (Hb.) have been observed to cause more damage to *rabi* onion (Saha, 1990). Infestation of these pests during initial stages of the crop growth (30-40 days after planting) generally results in extensive defoliation of the crop. An understanding of the seasonal incidence of the pests, as influenced by weather factors provides useful clues for their efficient management especially for deciding the most appropriate time of the insecticidal application. This in view, the present investigation was conducted.

MATERIAL AND METHODS

A bulk plot of 200 m^2 was raised and the incidence and the extent of infestation by *S. litura* and *S. exigua* was recorded. The larval population of *S. litura* and *S. exigua* were estimated at weekly intervals by destructive sampling of ten plants from each of 20 m^2 area selected at three locations in the entire bulk plot. The tubular onion leaves were opened and the number of larvae present inside were recorded at weekly intervals commencing from 46th standard week *i.e.*, 60 days after transplanting. To study the effect of meteorological data, simple correlations and multiple regression analysis were carriedout involving the pest population and weather parameters. The weekly interval meteorological data was collected from meteorological observatory at Regional Agricultural Research Station, Lam.

RESULTS AND DISCUSSION

The initial infestation of the pest was observed during the 46th standard week *i.e.*, 60 days after the onion crop was transplanted. The infestation increased gradually as the crop advanced. The peak population of 23.83 *Spodoptera litura* larvae per 10 plants was observed during the 52nd standard week. During this period the maximum and minimum temperatures were 27.06°C and 20.23°C and the morning and evening relative humidities were 92.87 and 70.62 per cent respectively (Table 1).

Simple correlation between larval population and weather parameters showed significant negative correlation with maximum temperature (r= -0.9065) and non-significant negative correlation with minimum temperature (r= -0.1304) and the correlation with morning relative humidity, evening relative humidity and total rainfall was positive and non-significant with 'r' values of 0.3795, 0.2829 and 0.2073, respectively (Table 2).

The multiple linear regression analysis between the weather parameters and the larval incidence (Table 2) revealed that all the weather parameters together significantly influenced the larval population to an extent of 84.77 per cent (R^2 = 0.8477). Maximum temperature was found to have independent effect on variation in larval population while the remaining four weather parameters *viz.*, minimum temperature, morning and evening relative humidities and rainfall were non-significant. The multiple linear regression equation fitted to predict the population fluctuations of *S. litura* on onion based on weather parameters is

$$Y = 179.3347 - 5.2552^{*} X_1 + 1.3612 X_2 - 0.657 X_3 - 0.5105 X_4 + 0.0183 X_5$$

For every 1°C decrease in maximum temperature over mean level there was a corresponding increase of 5.25 larvae per 10 plants.

Table 1: Influence of weather parameters on population fluctuation of S. litura, S. exigua, foliar damage and coccinellids predators in onion ecosystem during rabi, 2003-04.

Standard week	Duration	Average Teperature (°C)		Relative humidity (%)		Rain fall (mm)	Mean no. of adult larvae / 10 plants		Foliar damage (%)	Mean No. of adult coccinellids / 10 plants
		Maximum	Minimum	Morning	Evening		S. litura	S. exigua		
46	Nov 12-18	31.28	20.87	81.57	65.00	0.0	2.40 (1.69)^{g}	2.33 (1.64)^{i}	5.13 (13.08)^{h}	0.0 (0.70)^{i}
47	Nov 19-25	30.77	17.87	89.00	56.57	0.0	7.27 (2.78)^{e}	4.60 (2.25)^{g}	8.73 (17.18)^{g}	0.09 (1.17)^{h}
48	Nov 26-Dec 2	30.90	18.35	94.85	59.71	0.0	7.00 (2.73)^{e}	5.36 (2.41)^{f}	9.34 (17.79)^{g}	6.80 (2.69)^{e}
49	Dec 03-09	30.95	16.37	85.85	49.71	0.0	12.26 (3.57)^{d}	9.80 (3.20)^{e}	15.46 (23.15)^{f}	9.70 (3.18)^{d}
50	Dec 10-16	28.32	18.05	92.57	69.42	11.97	15.62 (4.01)^{c}	10.69 (3.34)^{dc}	18.20 (25.24)^{c}	15.60 (4.00)^{c}
51	Dec 17-23	28.21	15.80	90.28	58.59	0.0	19.38 (4.45)^{b}	11.83 (3.51)^{cd}	22.81 (28.52)^{b}	20.9 (4.62)^{b}
52	Dec 24-31	27.06	20.23	92.87	70.62	11.7	23.8 (4.92)^{a}	15.29 (3.97)^{b}	32.62 (34.82)^{a}	30.5 (5.56)^{a}
01	Jan 01-07	27.89	16.30	90.57	55.00	0.0	18.20 (4.32)^{b}	21.03 (4.63)^{a}	20.69 (27.05)^{c}	17.80 (4.27)^{c}
02	Jan 08-14	28.74	15.04	93.29	54.14	0.0	15.32 (3.97)^{c}	12.31 (3.57)^{c}	19.62 (26.28)^{cd}	4.2 (2.15)^{f}
03	Jan 15-21	30.04	15.39	92.86	52.29	0.0	4.64 (2.26)^{f}	3.10 (1.89)^{h}	18.83 (25.71)^{de}	2.10 (1.60)^{g}
F-test							Sig.	Sig.	Sig.	Sig.
SED							0.12	0.11	0.38	0.14
CD (0.05%)							0.26	0.25	0.80	0.30

Figures in parenthesis are √ transformed values. Sig : Significant Number followed by same letter in each column are not significantly different.

For initial infestation of *S. exigua* was noticed during 46th standard week *i.e.*, 60 days after transplantation. The larval density increased gradually as the crop advanced. Significantly higher larval population of 15.29 and 21.03 per ten plants were recorded during 52nd and 1st standard weeks, respectively at 125 to 130 days after transplantation of the crop (Table 2). Simple correlation between larval population and weather parameters indicated significant negative correlation with maximum temperature (r=-0.8186) and a non-significant and negative correlation with minimum temperature (r = -0.2299) and the correlation with remaining weather parameters was positive and non-significant (Table 2).

Multiple linear regression analysis of the larval population and weather parameters indicated that all the weather variables together accounted for 88.11 per cent variation in larval population (R^2 = 0.8811), which was significant (Table 2). Maximum temperature and evening relative humidity were found to have independent effect on variation in larval population while the remaining three weather variables were non-significant. The multiple linear regression equation fitted to predict the population fluctuations of *S. exigua* on onion based on weather variables is

$$Y = 201.50 - 5.7557^{*} X_1 + 3.4321 X_2 - 0.0312 X_3 - 1.3596^{*} X_4 + 0.0616 X_5$$

For every 1°C rise in maximum temperature over mean level, there was a corresponding reduction of 5.75 larvae per 10 plants. Significantly higher level of infestation of

Table 2: Simple correlation and multiple linear regression analysis of larval population of S. litura and S. exigua on certain weather parameters.

Weather parameters	Correlation coefficient (r)		Multiple linear regression					
	S. litura	S. exigua	Partial regression coefficient	*S. litura* Standard error	't' value	Partial regression coefficient	*S. exigua* Standard error	't' value
X_1 - Maximum temperature	-0.9065*	-0.8186*	-5.2552*	1.6793	3.1293	-5.7557*	1.2444	4.6250*
X_2 - Minimum temperature	-0.1304	-0.2299NS	1.3612NS	2.4996	0.5445	3.4321NS	1.8523	1.8528NS
X_3 - Relative humidity (8.30 hrs)	0.3795	0.2866NS	-0.0657NS	0.4556	0.1442	-0.0312NS	0.3376	0.0924NS
X_4 - Relative humidity (17.30 hrs)	0.2829	0.0657NS	-0.5105NS	0.8246	0.6191	-0.3596*	0.6110	2.2249*
X_5 - Total rainfall	0.2073	0.0964NS	0.0183NS	0.0630	0.2903	0.0616NS	0.0467	1.3198NS
	*Significant at 0.05 't' value = 0.6319 at 0.05		R^2 Value = 0:8477, Intercept=179.33 't' value = 2.08 at 0.05			R^2 Value = 0.881, Intercept=201.50 't' value = 2.08 at 0.05		

S.litura was recorded during the 51st and 52nd standard weeks in agreement with Rao *et. al.* (2000) who reported a peak infestation of *S. litura* larvae @ 2.5 per plant during 4th week of December on sunflower crop. Correlation of *S. litura* larval population with maximum temperature indicated a significant and negative relationship in conformity with the Sanjrani *et. al.* (1989) and Santha Olive (1999).

Significantly higher larval population of *S. exigua* was recorded during 52nd and 1st standard weeks in close conformity with Singh and Bichoo (1976), Sharma (1990) and Singh *et. al.* (1993) who reported the infestation of *S. exigua* on chick pea, soybean and linseed respectively, during the period from November to March. The larval population of *S. exigua* showed a significant and negative correlation with maximum temperate in conformation with Subba Rao and Subba Ratnam (1999).

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Journal
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External Morphology and Genitalia of Mango Leaf Cutting Weevil, *Deporaus marginatus* (Pascal) (Curculionidae : Coleopetra)

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ABSTRACT

External morphological features including genitalia of the adult male and female of mango leaf cutting weevil, *Deporaus marginatus* (Pascal) were studied. Adult sexual description was done on the basis of size, shape and colour of the body.

Key words : Mango Leaf Cutting Weevil, External Morphology and Genitalia

In the recent years, insect pests of mango have been taken seriously under intensive cropping systems of Andhra Pradesh. Mango leaf cutting weevil, *Deporaus marginatus* (Pascal) is considered as one of the important pests of mango, both on nursery and main field. Earlier, attempts were made to describe the morphology of this weevil by Fletcher (1914), Houston and Alwis (19334), Khanna (1952) and Butani (1993). However, the information is realized to be insufficient to identify and understand this pest, leaf cutting weevil. Hence attempts are made to observe and narrate the morphological characters including genitalia of this important pest of mango in South zone of Andhra Pradesh. The works of Mann and Singh (1979) and Pajini and Sidhu (1982) on different Coleopterans including Curculionid weevils were taken into consideration to project salient features of this weevil through appropriate means.

MATERIAL AND METHODS

Leaf weevils located around mango ecosystems were collected to study the morphology and sexual dimorphism of the weevil. Each part of the body *i.e.,* head, thorax, abdomen, wings and legs were observed separately and morphometrics were recorded with the help of micrometer and graph paper in laboratory. To study these structures, magnifiers of 10 x 4x ; 10 x 6x and 10 x 1.8x s were used in the stereo zoom microscope.

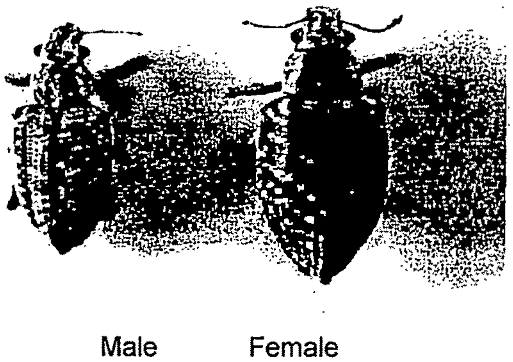
The distal portion of the abdominal segments of adult were separated carefully and boiled in 10 per cent potassium hydroxide (KOH) solution for 10-15 min. Later the materials were washed with water to remove the alkali and these were kept in glacial acetic acid for dehydration. Subsequently these were transferred to carboxylol for further clearing of tissue. Thus different parts of genitalia were dissected and observed under microscope with a lense of 6x1.8x. The genital parts were transferred onto a cavity slide with DPX mountant. These slides were kept in hot air oven set at temperature of 55°C for drying. The magnified parts of genital organs were photographed using microphotograph equipment. Genitalial parts of mango leaf cutting weevils of both male and female were also depicted using camera lucida (Prizm type).

RESULTS AND DISCUSSION

Adult weevils were found to be small to medium sized flat bodied with slightly convex at the end of distal portion of abdomen. Shiny blackish with yellowish white coloured patches possessing sub-recumbent spathulate setae all over the body including legs also were found to be common feature. Body was covered with parallely arranged fan shaped short scales. Males were brightly coloured and shorter than females (Kannan, 2001) (Plate 1).

Head with frons, flat piceous, black coloured densely covered with yellowish colour scales was wider than base of rostrum. Its central fovae was observed to be concealed by scales, with a row of few sub-recumbent spathulate setae by each eye. Eyes were found black, large, circular and moderately convex. Rostrum shiny black some what longer than its basal width, gradually narrowed from base to scrobes. It did not dilated at apex; dorsal area was narrow, sulcate, densely covered with ash coloured scales. Antennae were present in the middle of the rostrum. There were 11 segmented and moderately long, scape elongated, stout gradually clavate and finely

Plate 1: Male and female adults of mango leaf cutting weevil.



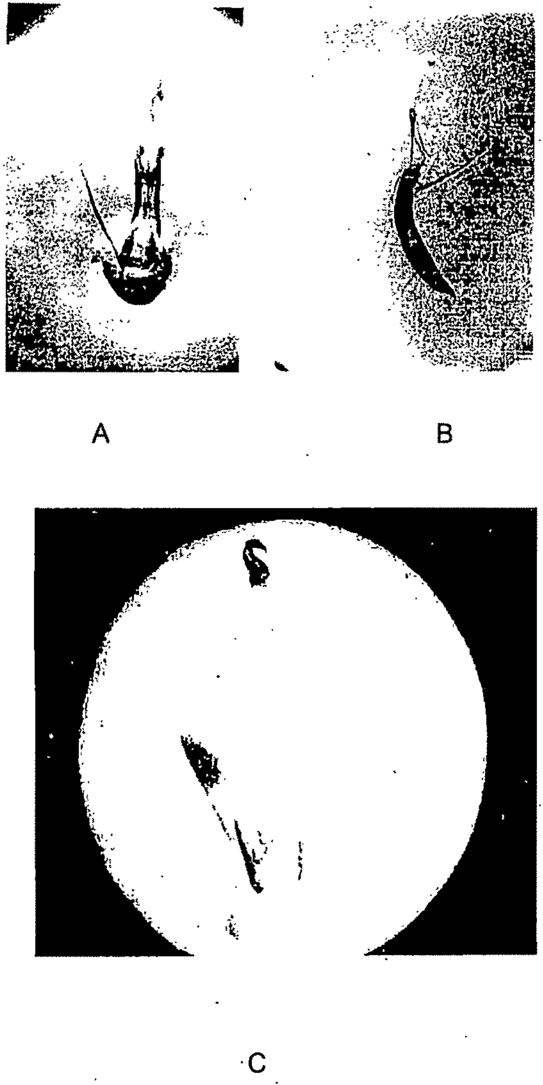


Plate 2 : Male and female genitalia of mango leaf cutting weevil. A and B : Male genitalia; C: Female genitalia

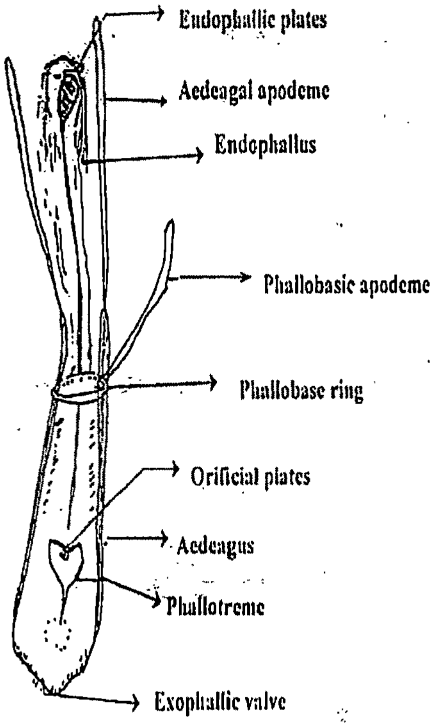


Fig.1: Male genitalia of mango leaf cutting weevil

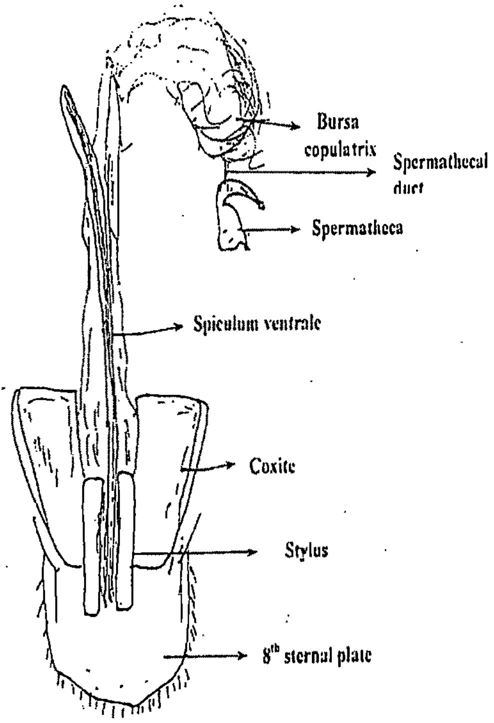


Fig.2: Female genitalia of mango leaf cutting weevil

uniformly all joints covered with small scales and all along pubescent. Last two segments of antennae were club shaped and bulged.

Prothorax fuscous, transversely flattened; remained continuous from head being narrow at the proximal part and broader at the distal end. Shiny black colour with white yellowish colour sparely arranged scales were common. Lateral sides of prothorax rounded broadest in middle lightly convex gradually narrowing to apex but not constricted.

Elytra convex, oblong strongly declivous posteriorly covering entire abdominal segments, broader at proximal part and narrow at distal end much wider and some what round, rectangular shoulders than the prothorax, their black surface covered with light yellowish ash coloured and longitudinal patches of white scales and distal end of wing pointed. Hind wings membranous, transparent light white in colour, small pubscent arranged in a straight line.

There is no modification of legs but, hind legs are slightly longer than fore and middle legs. Legs fuscous, covered with sub-erect setae and scales. Fore-coxae contiguous and placed in middle of prosternum, femora clavate, tibia slightly curved with a pair of tibial spurs on each leg. Tarsi setose 3 segmented, first tarsal segment some what larger than other two segments. Third segment is bilobed and spongy beneath, with two claws which are free.

Dorsal side of abdomen is softer, whereas ventral side is hard shiny brown colour with reddish white sub-erect setae and ochraceous scales.

Male genitalia(Plate 2 A & B and Fig.1)

Aedeagus slender, cylindrical in lateral view, curved and highly sclerotized aedeagal edges. In between aedeagal edges a phalotreme, distinct with two curved orificial plates. Aedeagal apodeme, long slender, weekly sclerotized and shorter than aedeagus. Membranous endophallus extended in between aedeagal apodemes with a long slender, small dumbel shaped armature.

Phallobase ring is situated at the junction of aedeagus adaedeagal apodeme. Single phallobase apodeme arise from phallobasering, long slender shorter than aedeagal apodeme.

Female genitalia (Plate 2C and Fig.2)

Female genitalia, with long ovipositor, sclerotized tubular stylus, 3-4 times logner than width, setose at apex. Coxite sclerotized, large rectangular in shape; speculum ventrale, long and thin, slender and 1.5 times longer than coxite. Bursa compulatrix, membranous, elongated and distally bulged. Spermatheca with cornu pointed and curved at apex, colum lying parallel to ramus.

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Journal
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Incidence of Lepidopteran Pests of Castor (*Ricinus communis* L.)

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ABSTRACT

The peak incidence of semilooper (*Achaea janata* Linn.) and tobacco caterpillar (*Spodoptera litura* Fab.) was observed during the first week of December and the fourth week of November, respectively. The incidence of shoot and capsule borer (*Conogethes punctiferalis* Guen.) was high during the first week of March. Correlation studies revealed that the semilooper population was negatively and significantly correlated with minimum temperature, positively and significantly correlated with morning relative humidity. In case of tobacco caterpillar both maximum and minimum temperatures were negatively and significantly correlated with the pest population. While morning RH was positively and significantly correlated with tobacco caterpillar population. With regard to shoot and capsule borer maximum temperature was positively and significantly correlated with capsule infestation, while morning and evening relative humidities were negatively and significantly correlated.

Key words : *Achaea janata, Spodoptera litura, Conogethes punctiferalis,* Castor

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop of Euphorbiaceae family, which plays an important role in the country's vegetable oil economy. In India castor is grown in an area of 7.32 million hectares with production of 8.01 million tonnes and productivity of 1094 kg/ha^{-1} (CMIE, 2004). Castor oil has wide array of uses. Castor crop is known to be infested with more than 100 insect pest species, but only a few are responsible for crop losses. The yield loss in castor due to insect pest species has been estimated in the range of 35-40% (Kolte, 1995). Among the lepidopteran pests castor semilooper, tobacco caterpillar, shoot and capsule borer are important pests on castor which cause a considerable yield loss. Incidence of the pests in relation to weather parameters is essential to know the peak period of occurrence. The present study was conducted to know the activity of the pests.

MATERIAL AND METHODS

The crop was sown on 20.10.04 at Agricultural College Farm, Bapatla. A popular variety "Jyothi" was selected for the experiment. The incidence of major pests of castor was recorded starting from first week after sowing till harvesting at weekly intervals. The influence of various weather parameters on the incidence of pests of castor was studied during the experimental period. The pest population was sampled in unprotected bulk plot of 210 m^2. The larval counts of semilooper and tobacco caterpillar were taken at weekly intervals on 25 plants which were randomly selected at 5 different locations. In case of shoot and capsule borer the per cent capsule infestation was noted. The extent of incidence of the pest was recorded by counting the number infested capsules to the total number of capsules on the 25 randomly selected plants at weekly intervals. It was converted to percentage with the following formula.

$$\text{Percent infestation of capsules} = \frac{\text{Number of capsules infested}}{\text{Total number of capsules}} \times 100$$

Simultaneously daily meteorological observations were taken from Meteorological Observatory, Bapatla. The data was subjected to simple correlations.

RESULTS AND DISCUSSION

The first incidence of *Achaea janata* was observed on 17th November with a mean population of 0.12 larvae/plant (Table 1). Peak incidence of *A. janata* was observed during first week of December with a population of 1.2 larvae/plant. The *A. janata* population gradually declined and was low on 15th December with a mean population of 0.04 larvae / plant. Correlation studies revealed that minimum temperature had significant negative association (r=-0.6632) with the pest population, while morning RH had significant positive association (r=0.4837). The weather factors maximum temperature and rainfall had non-significant negative association, (r=-0.3849 and -0.3255, respectively) but evening RH had non-significant positive association (r=0.0215) (Table 2).

Table 1 : Influence of weather parameters on the incidence of *A. janata*, *S. litura* and *C. punctiferalis* on castor during *rabi*, 2004-05.

Date of observation	Temperature (°C)		Relative humidity (%)		Rainfall (mm) X_5	Mean no. of *A. janata* larvae plant^{-1}	Mean no. of *S. litura* larvae plant^{-1}	Mean per cent capsule infestation plant^{-1}
	Max X_1	Min X_2	Morning X_3	Evening X_4				
Oct 20th	31.7	23.3	85.14	74.14	22.6	--	--	--
Oct 27th	32.3	23.4	88.42	74.14	1.3	0	0	0
Nov 03rd	30.0	22.0	88.00	76.57	37.6	0	1.12	0
Nov 10th	28.9	21.8	94.14	85.14	26.7	0	1.48	0
Nov 17th	31.2	21.1	93.14	74.71	2.0	0.12	8.00	0
Nov 24th	30.7	17.4	88.00	69.71	0	0.48	9.16	0
Dec 1st	30.3	17.5	96.28	75.14	0	1.20	4.16	0
Dec 8th	30.1	16.8	92.00	70.71	0	0.52	6.76	0
Dec 15th	30.1	17.5	94.42	81.28	0	0.04	9.00	0
Dec 22nd	30.3	17.1	93.57	65.42	0	0.36	8.48	0
Dec 29th	30.1	17.4	94.14	68.71	0	0.60	8.12	0
Jan 5th	29.9	17.9	90.57	67.71	0	0.40	4.84	0
Jan 12th	30.5	18.1	89.42	69.85	0	0.28	4.20	0
Jan 19th	30.3	17.4	94.00	66.57	0	0.12	0.88	0
Jan 26th	30.5	19.3	93.42	74.42	2.7	0.32	2.36	5.18
Feb 3rd	29.77	20.27	88.00	71.57	3.0	0.24	2.52	4.30
Feb 10th	30.61	17.82	90.71	68.85	0	0.12	1.08	11.07
Feb 17th	33.42	18.71	80.57	63.00	0	0	0.52	7.74
Feb 23rd	31.32	20.68	86.42	68.71	0	0	0	18.06
March 2nd	33.02	19.54	89.00	62.28	0	0	0	24.28
March 9th	32.18	20.91	78.14	72.42	0	0	0	14.16
March 16th	33.41	22.88	80.85	73.28	0	0	0	5.31
March 21st	32.70	23.47	80.14	70.71	0	0	0	7.16

The data on the occurrence of semilooper when subjected to multiple linear regression analysis the following equation was arrived (Table 3).

$$Y = -0.9635 + 0.0386\,X_1 - 0.1048^{*}\,X_2 + 0.0031\,X_3 + 0.0249\,X_4 - 0.0038\,X_5$$

The above equation indicated that for every 1°C decrease in minimum temperature over the mean level, there was a corresponding increase of 0.1048 semilooper larvae per 25 plants.

The initial incidence of *Spodoptera litura* was observed on 3rd November with a mean population of 1.12 larvae / plant (Table 1). *S. litura* population reached a peak level during the fourth week of November with 9.16 larvae per plant. The pest population then gradually decreased and again reached a peak level by 15th December (9.00 larvae / plant). The *S. litura* population was very low during third week of January (0.88 larvae / plant).

The correlation studies were worked out to find out the relationship between *S. litura* population and the major weather parameters. The results indicated that the relationship between the pest load and the maximum and minimum temperature was significant and negative, (r = -0.5168 and -0.6235, respectively) while with morning RH the relationship was significant and positive (r = 0.5807). The association between evening RH and *S. litura* population was non-significant and positive, (r =0.0626) but rainfall had non-significant negative association with pest load (r = -0.2950) (Table 2).

Table 2 : Simple correlation between weather parameters, A. janata, S. litura and Conogethes punctiferalis on castor during rabi, 2004-05.

Weather parameters	Correlation coefficient (r) with		
	A. Janata	*S. litura*	*C. puncti-feralis*
Maximum Temp.	-0.3849NS	-0.5168*	0.6445*
Minimum Temp.	-0.6632*	-0.6235*	0.1461NS
Morning RH	0.4837*	0.5807*	-0.4419*
Evening RH	0.0215NS	0.0626NS	-0.4284*
Rainfall	-0.3255NS	-0.2950NS	-0.2504NS

N=23, NS = Non-significant, * = Significant at 5% level.

The data when subjected to multiple linear regression analysis the following equation was derived (Table 3).

$$Y = 14.3087 - 0.6265\,X_1 - 0.5478\,X_2 + 0.0900\,X_3 + 0.1627\,X_4 - 0.1156X_5$$

The equation indicated no significant difference between the weather parameters and *S. litura* population.

In case of *Conogethes punctiferalis*, the first incidence was observed on 26th January with 5.18 per cent capsule infestation (Table 1). The capsule infestation reached peak level during the first week of March with 24.28 per cent capsule infestation. But low infestation of capsule borer was observed on 3rd February 4.30 per cent capsule infestation.

Table 3: Multiple Linear Regression between weather parameters and incidence of *A. janata*, *S. litura* and *C. punctiferalis* on castor during *rabi*, 2004-05.

Variable	*A. janata*			*S. litura*			*C. punctiferalis*		
	Regression coefficient	Standard error	t-value	Regression coefficient	Standard error	t-value	Regression coefficient	Standard error	t-value
Maximum Temperature	0.0386	0.0738	0.5237	-0.6265	0.8724	0.7181NS	3.9368	1.8611	2.1152*
Minimum Temperature	-0.1048	0.0419	2.4985*	-0.5478	0.4955	1.1056NS	-0.6328	1.0570	0.5987NS
Morning Relative humidity	0.0031	0.0154	0.2071NS	0.0900	0.1822	0.4940NS	0.0934	0.3887	0.2404NS
Evening Relative humidity	0.0249	0.0134	1.8535NS	0.1627	0.1590	1.0230NS	-0.1939	0.3392	0.5716NS
Rainfall	-0.0038	0.0071	0.5411NS	-0.1156	0.0849	1.3609NS	0.1151	0.1812	0.6356NS
R^2 = Per cent of variation attributed to the regression	Intercept (a) = -0.9635 R^2 = 0.55603			Intercept (a) = 14.3087 R^2 = 0.5509			Intercept (a) = -101.30 R^2 = 0.4713		

The correlation studies indicated that the relation between the maximum temperature and capsule infestation was significant and positive (r = 0.6445), whereas the minimum temperature showed non-significant but positive relation (r = 0.1461). The relationship between the morning and evening RH's and capsule infestation was significant but negative (r= -0.4419 and -0.4284, respectively), while rainfall had non-significant, negative relation (r= -0.2504) with capsule infestation (Table 2).

The data when subjected to multiple linear regression analysis the following equation was derived (Table 3).

$$Y = -101.30 + 3.9368^* X_1 - 0.6328 X_2 + 0.0934 X_3 - 0.1939 X_4 + 0.1151 X_5$$

The equation indicated that for every 1°C raise in maximum temperature over the mean level, there was a corresponding increase of 3.93 per cent capsule infestation.

The peak incidence of semilooper during first week of December, 2004 was in accordance with DOR (1999). Reports of DOR (1995) indicated that maximum temperature and rainfall were negatively correlated, while relative humidity was positively correlated with semilooper population, which supports the present findings. Peak activity of *S. litura* during fourth week of November, is in accordance with Thanki *et al.* (2003). The weather factors maximum and minimum temperatures were significant and negatively correlated with *s. litura* population, which was well supported by Thanki *et al.* (2003). Reports of DOR (1999) indicated that highest incidence of *C. punctiferalis* was observed during the month of March supports the present findings. The weather factors maximum and minimum temperatures having positive correlation with capsule infestation is in approximation with Tirupati Reddy (2002)

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Bioefficacy of *Bacillus thuringiensis* Ber. as Formulation, Pure Culture and Culture Filtrate Against *Spodoptera litura* (Fab.)

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ABSTRACT

The median effective concentration (EC_{50}) values for the three forms of *B.t. viz.*, formulation (Dipel 8L), pure culture (cells) and culture filtrate are 0.26% (vol./vol), 7.5 x 10^7 cells/ml and 1:34 dilution, respectively with reference to 50 per cent successful pupation after allowing final instar larvae of *S. litura* to feed on *B.t* treated castor leaves continuously for three days. *B.t.* culture filtrate was more effective against the final instar laryae of *S. litura* in resulting higher larval mortality, feeding inhibition and reduction in pupal weights, pupation and adult emergence compared to the same effects due to formulation and pure culture of *B.t.*

Key workds: *Bacillus thuringiensis*, Spodoptera

The rapidly increasing magnitude and complexity of insecticidal resistance problems and hazards involved in their use are forcing investigations on alternate control measures and increasing interest is being taken in the possible role of insect pathogens in pest management. Among the insect pathogens studied so far, *Bacillus thuringiensis* Ber. (*B.t.*) has been extensively investigated (Narayanan *et al.*, 1970).

The relative stability of the toxic crystals and the spores, and the ease with which *B.t.* can be produced on a wide variety of media, have led to its use world over. Lepidopteran insects are more or less sensitive to the toxic action of crystals alone, or combined action of the spores and crystals or vegetative cells or exotoxins. Keeping this in view the present investigation was carried out to test the pathogenicity of the three forms of *B.t. viz.*, formulation (Dipel 8L), pure culture (cells) and culture filtrate against the tobacco caterpillar, *Spodoptera litura* (Fabricius) in the laboratory.

MATERIAL AND METHODS

The culture of *S. litura* was reared on castor leaves in the laboratory (temperature 27±4°C and relative humidity 70%). Pure culture of *B.t.* var. *kurstaki* (*B.t.k.*) was obtained by growing the pathogen on nutrient agar medium (Gainey *et al.*, 1956) using the commercial formulation (Dipel 8L, Strain : HD-1, 3a, 3b, 17,600) as the initial inoculum.

The pure culture of *B.t.* was harvested from nutrient agar slants by using sterile water to obtain the stock suspension from which dilutions of 10^{-1}, 10^{-2}, 10^{-3}, and 10^{-4} were obtained by serial dilution. The concentration of bacterial cells in each of the dilutions and that of the stock suspension was estimated by plate count method (Fox, 1996). One ml of the suspension from each of the dilutions as well as stock suspension was aseptically transferred to agar plates. After incubation for 24 hours the colonies developed on the agar plates were counted with the help of Quebec colony counter. The concentrations of bacterial cells in the respect of each dilution as well as suspension was estimated using the formula,

$$\frac{\text{No. of cells in the dilution x dilution factor}}{\text{1 ml of suspension}}$$

The concentrations of the stock solution and dilutions were estimated to be 4.2 x 10^9, 4.2 x 10^8, 4.2 x 10^7, 4.2 x 10^6 and 4.2 x 10^5 cells/ml, respectively. Stock suspension as well as the dilutions of *B.t.k.* cells was used to test the pathogenicity.

Stock suspension of 1:100 dilution (4.2 x 10^7 cell/ml) was used to inoculate the nutrient broth, which was prepared in the same manner as the nutrient agar medium but for the addition of agar agar. The inoculated nutrient broth was incubated for 48 hours undisturbed and filtered using bacterial proof filter. The *B.t.k.* culture filtrate was further serially diluted to obtain dilutions of 1:10, 1:20, 1:30, 1:40 and 1:50, and tested for bio-efficacy.

The median effective concentration (EC_{50}) values for all the three forms of *B.t.k. viz.*, the formulation (Dipel 8 L), pure culture and culture filtrate were calculated with reference to its effect on pupation of the final instar larvae of *S. litura* by using leaf dip method (Deshmukh and Mathai, 1991). The experiment was carried out with three replications with 30 larvae per replication. Further, data on larval mortality, feeding inhibition, weight loss, reduction in pupal weight and adult emergence were also recorded.

All the experiments were carried out in completely randomized block design and the data obtained were analysed by using analysis of variance technique (Gomez and Gomez, 1984). Median effective concentrations were calculated following probit analysis (Finney, 1971).

RESULTS AND DISCUSSION

The EC_{50} values for *B.t.* formulation, Dipel 8L; pure culture and culture filtrate were 0.26% (vol/vol), 7.5×10^7 cells/ml and 1:34 dilution, respectively. The present EC_{50} values of *B.t.* formulation (Dipel 8 L) are much higher compared to the earlier reported LC_{50} values, 0.17% (vol/vol) against third instar larvae of *S. litura* (Sree Latha *et al.*, 2002) and *Heliothis armigera* Hub. (Purohit and Deshpande, 1991), and 0.11% against third instar larvae of *Achae janata* (L.) (Deshmukh and Deshpande, 1989). This might be due to variation in the larval species, instar and the selected effect *i.e.*, pupation instead of mortality observed for. The corresponding x^2 values, regression equations, slope and fiducial limits were also calculated (Table 1). The slope of the regression line was more for the formulation followed by culture filtrate and pure culture, there by the fiducial limits are very narrow, narrow and wide, respectively.

The pathogenic effects of all the three forms of *B.t.* are concentration dependent. Larval mortality was the highest (30.4 to 83.3%) in the *B.t.* culture filtrate @ 1:50 to 1:10 dilutions compared to (22.1 to 76.8%) in the *B.t.* formulation @ 0.15 to 0.35% and *B.t.* pure culture (25.5 to 75.0%) @ 4.2×10^5 to 4.2×10^9 cells/ml.

Where as reduction in food consumption was the highest 23.0 to 64.4% in *B.t.* culture filtrate followed by 21.9 to 57.1% in *B.t.* pure culture and 12.5 to 45.5% in *B.t.* formulation. Likewise per cent reduction in pupal weight was the highest (12.3 to 45.1) in *B.t.* culture filtrate followed by *B.t.* pure culture (6.4 to 37.4) and *B.t.* formulation (2.6 to 36.7).

However, reduction in larval weight was the highest (7.7 to 63.3%) in the formulation followed by the pure culture (6.1 to 48.0%) and the culture filtrate (3.2 to 22.1%). Similarly, the respective per cent normal pupation and adult emergence were the lowest (22.1 to 77.9 & 19.8 to 77.9) in

Table 1: Median effective concentration (EC_{50}) of *B.t.k.* as a formulation (Dipel 8L), pure culture and culture filtrate against the final instar larvae of *S. litura*.

Treatment	X^2 value	Regression equation	Slope (b) ± standard error	EC_{50}	Fiducial limits
Dipel 8L	4.4879 (p=0.9756)	Y=7.3166+3.9447x	3.9447±0.5309	0.26% (vol/vol)	0.24±0.28
Culture filtrate	6.9280 (p=0.9980)	Y=8.1923+2.0952x	0.0952±0.2794	1:3 (dilution)	1.29±1.39
Pure culture	0.6342 (p=0.9999)	Y=2.3274+0.3393x	0.3393±0.0469	7.5×10^7 (cells/ml)	3.1×10^{-8} $\pm1.7\times10^{-8}$

Table 2: Effect of *B.t.k.* formulation, (Dipel 8L on larval mortality, food consumption, larval weight, pupation and adult emergence of f final instar larvae of *S. litura*.

B.t.k formulation (Dipel 8L)	Per cent					
	Larval mortality	Reduction in food consumption	Larval weight reduction	Reduction in pupal weight	Normal pupae	Normal pupae
0.15%	22.1^e	12.5^e	7.7^e	2.6^e	77.9^a	77.9^a
	(30.0)	(20.6)	(16.1)	(62.0)	(62.0)	(62.0)
0.20%	32.93^d	23.3^d	34.5^d	66.7^b	66.7^b	66.7^b
	(35.0)	(28.8)	(36.0)	(54.8)	(54.8)	(54.8)
0.25%	93.9^c	29.4^c	46.2^c	55.4^c	55.4^c	52.4^c
	(41.5)	(32.8)	(42.8)	(48.1)	(48.1)	(46.3)
0.30%	54.9^b	38.3^b	58.1^b	44.0^d	44.0^d	42.9^c
	(47.8)	(38.2)	(49.7)	(41.6)	(41.6)	(40.9)
0.35%	76.8^a	45.5^a	63.3^a	22.1^e	22.1^e	19.8^d
	(61.2)	(42.4)	(52.7)	(28.0)	(28.0)	(26.4)
F-test	Sig.	Sig	Sig.	Sig.	Sig.	Sig.
SEd	0.5	0.5	0.6	1.7	1.7	1.8
CD (P-0.05)	1.2	1.2	1.3	3.8	3.8	4.1

In each column figures followed by same letter are statistically non-significant or not differing

Table 3 : Effect of *B.t.k.* pure culture on larval mortality, food consumption, larval weight, pupation and adult emergence of final instar larvae of *S. litura*.

B.t.k culture (cell/ml)	Per cent					
	Larval mortality	Reduction in food consumption	Larval weight reduction	Reduction in pupal weight	Normal pupae	Normal Adults
$4.2x10^5$	25.5e	21.9e	6.1e	6.4e	74.5a	74.1a
	(30.3)	(27.9)	(14.3)	(14.7)	(58.1)	(59.4)
$4.2x10^6$	27.0d	32.1a	16.9d	14.4d	63.0b	62.3b
	(37.5)	(34.5)	(24.3)	(22.3)	(52.5)	(52.1)
$4.2x10^7$	46.8c	38.9c	28.20	20.3c	53.2c	52.5c
	(43.29)	(38.6)	(32.0)	(26.8)	(46.8)	(45.3)
$4.2x10^8$	59.1b	46.5b	40.4b	26.3b	40.9d	39.8d
	(50.4)	(45.0)	(39.5)	(30.9)	(39.7)	(37.3)
$4.2x10^9$	75.0a	57.1a	48.0a	37.4a	25.0c	23.5
	(63.4)	(49.1)	(43.9)	(37.7)	(29.9)	(26.3)
F-test	Sig	Sig	Sig	Sig	Sig	Sig
SEd	2.03	0.7	0.5	0.7	1.4	1.7
CD (P=0.05)	4.5	1.6	1.1	1.5	3.1	3.7

In each column figures followed by same letter are statistically non-significant or not differing

the formulation followed by the pure culture (25.0 to 74.5 & 23.5 to 74.1) and the culture filtrate (16.7 to 69.6 & 7.8 to 68.1) (Tables 2, 3 & 4).

B.t. is a spore forming grampositive bacterium whose major distinctive characteristic is the formation of a proteinaceous parasporal crystal (δ-endotoxin) during the sporulation process (Lambert and Pefereon, 1992). In addition to δ-endotoxin the vegetative stages of *B.t.* produce thermostable exotoxins like β-exotoxins. These toxins are responsible for the insecticidal activity of *B.t.* (Burgerjon and Barjac, 1960).

β-exotoxin is small, water soluble, heat soluble and dialyzable molecule that is excreted by the bacterial cells into the surrounding medium. The toxin is toxic to a broader range of insects than that of the *B.t.* crystal endotoxin. The effect of β-exotoxin varied greatly with dose, mode and time of application. Sub-lethal doses exotoxins cause interference in larval moulting resulting in appropriate abnormalities. Supernatant of *B.t.* cultures contain this thermostable β-exotoxin or thurngiensin which *in vivo* acts as a preferential inhibitor of ribosomal RNA synthesis. The present study suggests that the insect pathological effects observed may be due to thuringiensin (Paumard Rigar *et al.*, 1990 and Cooper *et al.*, 1990) or other exotoxins in culture filtrate.

Table 4 : Effect of *B.t.k.* culture filtrate onlarval mortality, food consumption, larval weight, pupation and adult emergence of final instar larvae of *S. litura*.

B.t.k culture (Dilutions)	Per cent					
	Larval mortality	Reduction in food consumption	Larval weight reduction	Reduction in pupal weight	Normal pupae	Normal Adults
1:50	30.4e	23.0e	3.2e	12.3e	69.6a	68.1a
	(33.4)	(28.6)	(10.1)	(20.5)	(56.6)	(55.7)
1:40	44.0d	32.1d	7.7d	19.0d	55.0b	54.1b
	(41.6)	(34.5)	(16.0)	(28.9)	(48.4)	(47.4)
1:30	61.6c	42.6c	11.7c	28.7c	38.4c	35.0c
	(51.7)	(40.9)	(20.0)	(32.4)	(38.3)	(36.3)
1:20	72.1b	55.6b	17.8b	32.3b	27.9d	21.3d
	(58.1)	(48.1)	(24.9)	(37.1)	(31.8)	(27.4)
1:10	83.3e	64.4a	22.1a	45.1a	16.7e	4.8e
	(65.9)	(53.3)	(28.0)	(42.2)	(24.0)	(15.9)
F-test	Sig	Sig	Sig	Sig	Sig	Sig
Sed	0.8	0.9	1.3	0.9	2.5	2.4
CD (P=0.05)	1.8	1.9	2.8	1.9	5.6	5.4

In each column figures followed by same letter are statistically non-significant or not differing

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Effect of Gypsum and Zinc Application on Growth and Yield in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted to study the effect of gypsum and zinc application on growth and yield in two different cultivars of groundnut. Application of different levels of gypsum significantly increased the number of branches, root dry weight, leaf area index and flower to pod ratio and thereby yield of groundnut and increased further when zinc as zinc sulphate was added with gypsum. Highest kernel yield was obtained with gypsum @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1}, followed by gypsum @ 500 kg ha^{-1} + Zn @ 25 kg ha^{-1}. Among the two cultivars cv. G-201 (semi-spreading type) was more responsive to gypsum and zinc application and superior to cv. TMV-2 (bunch type).

Key words : Gypsum, Zinc, Groundnut

Groundnut (*Arachis hypogaea* L.) is the premier oilseed crop of India and contributes nearly 40% of the total oil seed production, but the average yield of the crop in India is as low as 900 kg ha^{-1} (Bandyopadhyay *et. al.*, 2000). Among the several constraints, improper nutrient management is important for low productivity. Apart from the major nutrients, groundnut crop requires adequate supply of calcium for maximum yield as it plays a direct role in the pod growth and development (Kanwar *et. al.*, 1983). On the other hand, zinc deficiency has been reported to be a major problem in a number of crops as Indian soils are generally deficient in zinc. Application of zinc to groundnut was found to increase the vegetative growth, root and shoot dry weights (Malewar *et. al.*, 1993) and pod yield (Ramamoorthy and Sudarshan, 1992). However, a wide consistency in response of groundnut to fertilizer application is noticed (Reddy, 1988) and the conclusive evidences on balanced nutrition of groundnut are still meagre and fragmentary in coverage. There is a need to work out nutrient management strategy specific to calcium and zinc nutrition to increase the production level. Hence an attempt has been made involving gypsum and zinc to achieve the maximum growth and yield of groundnut.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm, Bapatla, during the *rabi*, 2001-02. Seven treatments consisting of Control (T$_1$); Gypsum soil application @ 250 kg ha^{-1} (T$_2$); Gypsum soil application @ 500 kg ha^{-1} (T$_3$); Gypsum soil application @ 750 kg ha^{-1} (T$_4$); T$_2$ + zinc basal application @ 25 kg ha^{-1} (T$_5$); T$_3$ + zinc basal application @ 25 kg ha^{-1} (T$_6$); T$_4$ + zinc basal application @ 25 kg ha^{-1} (T$_7$) were tried on two cultivars viz., G-201 (Kaushal), a semi-spreading type (V$_1$) and TMV-2, a bunch type variety (V$_2$) adopting a 2 factor randomized block design with three replications. Gypsum was applied to the crop at the pegging zone at 21 DAS. All the treatments received the recommended dose of 30 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1}. Data on growth parameters were recorded at 15 days interval and data recorded on 75 DAS are presented in Tables 1 and 2. The crop was harvested at 105 DAS when more than 80 per cent of pods showed dark streaks on the inner side of the shell wall.

RESULTS AND DISCUSSION

Number of branches per plant

In the present investigation gypsum application @ 500 and 750 kg ha^{-1} produced significantly higher number of branches per plant (Table 1). Similar results were reported by Agasimani and Hosamani (1990) and Ursal *et. al.* (1994). Maximum number of branches were recorded with gypsum @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1}. Being semi-spreading in nature cv G-201 was more responsive to gypsum and zinc application in producing significantly higher number of branches.

Root dry weight

All treatments were found to differ significantly from control and with increase in gypsum levels in respect to root dry weight (Table 1). Highest root dry weight was given

Table 1: Effect of gypsum and zinc application on number of branches, root dry weight and LAI at 75 DAS and flower to pod ratio.

	No. of branches per plant	Root dry weight (g $plant^{-1}$)	LAI	Flower to pod ratio
Treatments				
Control (T_1)	8.65	0.45	2.62	2.10
Gypsum @ 250 kg ha^{-1} (T_2)	9.52	0.54	3.13	1.77
Gypsum @ 500 kg ha^{-1} (T_3)	10.18	0.62	3.39	1.69
Gypsum @ 750 kg ha^{-1} (T_4)	10.43	0.71	3.66	1.69
T_2 + zinc @ 25 kg ha^{-1} (T_5)	9.20	0.58	3.36	1.75
T_3 + zinc @ 25 kg ha^{-1} (T_6)	10.80	0.66	3.73	1.69
T_4 + zinc @ 25 kg ha^{-1} (T_7)	11.27	0.76	3.94	1.69
SEm±	0.202	0.18	0.073	0.059
CD (0.05)	0.415	0.036	0.150	0.122
Cultivars				
G-201 (V1)	13.58	0.70	3.71	1.75
TMV-2 (V2)	6.44	0.53	3.10	1.78
SEm±	0.108	0.009	0.039	0.032
CD (0.05)	0.222	0.019	0.08	NS
Interactions				
T_1V_1	11.70	0.45	2.77	2.09
T_1V_2	5.60	0.44	2.47	2.10
T_2V_1	12.87	0.63	3.49	1.76
T_2V_2	6.17	0.46	2.77	1.78
T_3V_1	14.07	0.72	3.71	1.67
T_3V_2	6.30	0.53	3.06	1.70
T_4V_1	14.30	0.82	3.97	1.67
T_4V_2	6.57	0.61	3.34	1.70
T_5V_1	12.37	0.68	3.78	1.74
T_5V_2	6.03	0.50	2.94	1.75
T_6V_1	14.67	0.75	4.03	1.67
T_6V_2	6.93	0.56	3.42	1.70
T_7V_1	15.10	0.88	4.19	1.67
T_7V_2	7.45	0.63	3.68	1.70
SEm±	0.285	0.025	0.103	0.084
CD (0.05)	0.587	0.051	NS	NS

NS = Non-significant

by treatment gypsum @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1} significant increase in root and shoot dry weights were also noticed by Malewar *et. al.* (1993) with 20 kg Zn ha^{-1} in groundnut.

Leaf area index (LAI)

The minimum and maximum LAI were recorded in control and with gypsum application @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1} respectively at 75 DAS (Table 1). LAI increased with the levels of gypsum application and further when zinc was added to different gypsum levels. This increment might be due to increase in leaf area per plant as an influence of calcium and zinc, which help in synthesis of growth hormone, auxin. Puste and Jana (1998) observed that application of 20 kg $ZnSO_4$ ha^{-1} greatly influenced LAI in pigeonpea. Increment in leaf area was noticed by Geetha *et. al.* (1996) and El Zeiny *et. al.*(1998).

Flower to pod ratio

There was no significant difference in flower to pod ratio between two cultivars (Table 1). However, all the treatments differed significantly from control in respect of flower to pod ratio and least flower to pod ratio was observed with the application of gypsum @ 500 kg ha^{-1} and 750 kg ha^{-1} alone or in combination with Zn @ 25 kg ha^{-1}. Chitkala Devi (1985) also noticed similar trends in number of pegs per plant and peg to pod ratio.

Yield and yield components

Total number of pods and filled pods $plant^{-1}$ increased significantly with the increase in levels of gypsum and further when zinc was added with gypsum and maximum was recorded with gypsum @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1} (Table 2). Cultivar G-201 produced significantly higher total number of pods but there was no significant difference between the cultivars with regard to number of filled pods. These results are in agreement with the findings of Agasimani and Hosamani (1990), Ursal *et. al.* (1994) and Devakumar and Giri (1999).

100 kernel weight obtained with application of gypsum @ 500 kg ha^{-1}, 750 kg ha^{-1} and gypsum @ 500 kg ha^{-1} + Zn @ 25 kg ha^{-1} were similar with each other (Table 2). However, highest 100 kernel weight was recorded with gypsum @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1} in cultivar G-201. Highest shelling percentage was recorded with gypsum @ 500 kg ha^{-1} + Zn @ 25 kg ha^{-1} and gypsum 750 kg ha^{-1} + Zn @ 25 kg ha^{-1} followed by gypsum @ 500 kg ha^{-1} and gypsum 750 kg ha^{-1} alone. Similar results were observed by Ursal *et. al.* (1994), Krishna *et. al.* (1997) and Devakumar and Giri (1999).

All the treatments produced significantly higher yields over control. Highest kernel yield was recorded with gypsum @ 750 kg ha^{-1} + Zn @ 25 kg ha^{-1} followed by gypsum @ 500 kg ha^{-1} + Zn @ 25 kg ha^{-1} (Table 2). Cultivar G-201 produced significantly higher yield than Cv.TMV-2. These results corroborate the findings of Ursal *et. al.* (1994), Krishna *et. al.* (1997) and Noor *et. al.* (1998).

Calcium and sulphur in gypsum might have encouraged total biomass production and kernel development in groundnut which finally reflected to higher yield (Devakumar and Giri, 1999). Number of filled pods, 100 kernel weight and finally the yield increased due to Zn application as it helps in better growth of the plant (Krihsna *et. al.* 1997).

Table 2: Effect of gypsum and zinc application on yield and yield components.

	Total no. of pods	No. of filled pods	100 kernel weight (g)	Shelling percentage	Kernel yield (t ha^{-1})
Treatments					
Control (T_1)	16.67	11.74	34.13	71.35 (8.48)	1.16
Gypsum @					
250 kg ha^{-1} (T_2)	18.00	15.07	37.28	72.08 (8.52)	1.29
500 kg ha^{-1} (T_3)	20.40	17.10	40.50	74.53 (8.66)	1.43
750 kg ha^{-1} (T_4)	21.89	18.99	42.65	74.55 (8.66)	1.44
T_2 + zinc @ 25 kg ha^{-1} (T_5)	19.74	16.39	38.48	72.35 (8.53)	1.32
T_3 + zinc @ 25 kg ha^{-1} (T_6)	21.73	18.68	41.52	74.80 (8.68)	1.50
T_4 + zinc @ 25 kg ha^{-1} (T_7)	22.38	19.48	44.52	74.80 (8.68)	1.58
SEm+	0.159	0.313	1.044	0.068	0.054
CD (0.05)	0.326	0.643	2.147	0.139	0.112
Cultivars					
G-201(V1)	19.90	16.62	42.62	73.55 (8.60)	1.42
TMV-2 (V2)	20.32	16.91	37.11	73.44 (8.60)	1.35
SEm+	0.085	0.167	0.558	0.036	0.029
CD (0.05)	0.174	NS	1.148	NS	0.06
Interactions					
T_1V_1	16.40	11.60	38.37	71.70 (8.50)	1.21
T_1V_2	16.93	11.89	29.97	71.00 (8.46)	1.11
T_2V_1	17.63	14.83	40.50	72.00 (8.52)	1.34
T_2V_2	18.36	15.19	34.07	72.10 (8.52)	1.24
T_3V_1	20.13	16.73	42.97	74.54 (8.66)	1.44
T_3V_2	20.67	17.46	38.07	74.53 (8.66)	1.41
T_4V_1	21.77	18.67	45.20	74.55 (8.66)	1.47
T_4V_2	22.00	19.30	40.10	74.53 (8.66)	1.40
T_5V_1	19.47	16.27	41.80	72.40 (8.54)	1.34
T_5V_2	20.00	16.51	35.17	72.30 (8.53)	1.29
T_6V_1	21.83	18.93	43.47	74.80 (8.68)	1.54
T_6V_2	21.62	18.43	39.57	74.80 (8.68)	1.46
T_7V_1	22.10	19.33	46.07	74.80 (8.68)	1.62
T_7V_2	22.65	19.62	42.97	74.80 (8.68)	1.54
SEm+	0.224	0.443	1.478	0.096	0.077
CD (0.05)	0.461	NS	NS	NS	NS

Figures in parentheses are transformed values, NS = Non-significant

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Influence of Teak Based Agroforestry Systems on the Yield and Yield Components of Groundnut

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ABSTRACT

A field experiment was conducted during kharif 2004 to study the influence of teak based agroforestry systems on the yield and yield components of associated crop – groundnut at Main Agricultural Research Station, Dharwad. The experiment was laid out in a split-split plot design with 4 replications and 16 treatments. The results indicated that the yield and yield components (number of pods per plant, hundred kernel weight, shelling percentage and harvest index) increased with increase in distance from teak row and also recorded higher on Western side as compared to Eastern side in all teak based agroforestry systems. The extent of reduction of pod yield was 41.17,37.73 and 39.69% in association with teak, teak + grass and teak + subabul respectively compared to sole groundnut.

Key words: Agroforestry, Teak, Subabul, Grass, Groundnut

Agroforestry is a collective term for all land use systems and practices in which woody plants (tree/shrubs) are deliberately combined with herbaceous crops and/or annuals on the same land management unit with some form of spatial arrangement or in sequence (Anon, 1976). Teak is one of the valuable species which can be successfully cultivated in agroforestry system. It is considered as king of timber species. It is a deciduous tree, grows straight, has cylindrical bole, sparse canopy and deep root system which together make it more suitable for agroforestry system. While, it is commonly thought that no herbaceous annual crop can successfully thrive and produce normal yield under trees, because of the so called root and shade effects. Not much research work has been done on the combination of trees and annual crops, especially under rainfed conditions. The reason for this paucity of information appears to be the dominance of entrenched notion that trees and annual crops are mutually incompatible (Nadagoud, 1990). Therefore, to find out an efficient agroforestry system, particularly for red gravelly soil region, the present investigation was undertaken.

MATERIAL AND METHODS

The field experiment was conducted to study the effect of different teak based agroforestry systems on groundnut yield during *Kharif* 2004 at Main Agricultural Research Station, Dharwad. The soil of the experimental field was red gravelly with 38.5% coarse sand, 29.6% fine sand, 15.2% silt and 16.7% clay. The pH and EC were 5.92 and 0.52 dSm^{-1} respectively. The experiment was laid out in a split – split plot design with 4 replications and 16 treatments. The treatments comprised of different Agroforestry systems, directions from teak row and distance from teak row. Teak was planted during the year 1984 at 10 m and 20 m alleys (2 m intra- row spacing). Along the teak row, on either side of teak alleys, grass slips (or) subabul seedlings were planted at 60 cm between rows and 60 cm between 2 plants for grass and 20 cm for subabul. Both grass and subabul were harvested for fodder purpose and served as live bund to prevent runoff of rain water. The observations were made upto 5 m on either side of 20 m teak alley to facilitate uniformity with 10 m teak alley. Pods from net plot were harvested, dried and weight was recorded and pod yield in kg/ha and harvest index were calculated. The dry weight of 100 kernels drawn randomly from net plot was recorded and expressed in g per plant. Five hundred grams of developed pods from net plot were hand decorticated and shelling percentage was worked out. The data recorded were analysed statistically following the procedure described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Number of pods per plant (Table 1) was significantly higher in sole crop (11.74) and decreased in groundnut with teak (45.05%), teak + grass (38.67%) and teak + subabul (42.67%). Higher number of pods per plant was recorded on western side (8.15) than eastern side of teak row (7.90). Number of pods per plant increased significantly from 0-1 m (5.95) to 4-5 m (10.11)

Table 1: Number of pods per plant of groundnut as influenced by agroforestry system, direction and distance at harvest.

DR/DS	Agroforestry system				
	GN	GN+T	GN+ T+G	GN+T+ Sb	Mean
DR-E					
DS 0-1	11.37	3.52	5.37	3.62	5.97
DS4-5	12.27	8.49	9.86	8.77	9.84
Mean	11.82	6.00	7.61	6.19	-
DR-W					
DS 0-1	11.52	4.53	3.17	4.52	5.93
DS4-5	11.82	9.27	10.42	10.02	10.38
Mean	11.67	6.90	6.79	7.27	-
DS					
DS 0-1	11.44	4.02	4.27	4.07	5.95
DS 4-5	12.04	8.88	10.14	9.39	10.11
Mean for AFS	11.74	6.45	7.20	6.73	-

For comparison of	S.Em±	CD 5%
AFS	0.039	0.126
DR	0.020	0.061
DS	0.027	0.078
AFS-DR	0.048	0.153
AFS-DS	0.054	0.156
DR-DS	0.033	0.131
AFS-DR-DS	0.163	NS

AFS - Agroforestry systems., GN- Sole groundnut, GN+T - Groundnut + Teak, GN + T + G = Groundnut + Teak + Grass, G + T + Sb - Groundnut + Teak + Subabul DR-W : Direction - western side of teak row, DR-E: Direction - Eastern side of teak row, DS - Distance from teak row in meters (1-5), NS - Non significant.

Table 2: Pod yield per hectare (kg) of groundnut as influenced by agroforestry system, direction and distance at harvest

DR/DS	Agroforestry system				
	GN	GN+T	GN+T+G	GN+T+Sb	Mean
DR-E					
DS 0-1	1435.80	279.60	323.30	279.60	579.57
DS4-5	1198.30	1173.30	1310.80	1117.10	1199.87
Mean	1317.05	726.45	817.05	698.35	-
DR-W					
DS 0-1	1348.30	310.80	323.30	385.80	592.05
DS4-5	1292.10	1339.20	1326.70	1398.30	1339.07
Mean	1320.20	825.00	825.00	892.05	-
DS					
DS 0-1	1392.05	295.20	323.30	332.70	585.81
DS 4-5	1245.20	1256.25	1318.75	1257.70	1269.47
Mean for AFS	1318.62	775.72	821.02	795.20	-

For comparison of	S.Em±	CD 5%
AFS	5.790	18.529
DR	1.963	6.051
DS	2.489	7.264
AFS-DR	6.422	20.408
AFS-DS	4.977	14.527
DR-DS	3.170	12.390
AFS-DR-DS	17.708	NS

distance from teak row. Higher pod yield (Table 2) was observed in sole groundnut as compared to agroforestry system. The extent of reduction of pod yield was 41.17, 37.73 and 39.69 per cent in association with teak, teak + grass and teak + subabul respectively compared to sole groundnut. Pod yield was significantly higher on western side of teak line than eastern side of teak line and also increased with increase in distance from teak row as compared to 0-1 m distance.

Table 3: Hundred kernel weight (g) of groundnut as influenced by agroforestry system, direction and distance at harvest.

DR/DS	Agroforestry system				
	GN	GN+T	GN+T+G	GN+T+Sb	Mean
DR-E					
DS 0-1	42.50	16.60	16.70	14.60	22.60
DS4-5	42.40	38.10	37.70	37.87	39.01
Mean	42.45	27.35	27.20	26.23	-
DR-W					
DS 0-1	46.60	18.60	18.30	16.20	24.92
DS4-5	45.40	39.10	40.40	40.00	41.22
Mean	46.00	28.85	29.35	28.10	-
DS					
DS 0-1	44.55	17.60	17.50	15.40	23.76
DS 4-5	43.90	38.60	39.05	38.93	40.12
Mean for AFS	44.22	28.10	28.27	27.16	-

For comparison of	S.Em±	CD 5%
AFS	0.153	0.488
DR	0.063	0.194
DS	0.050	0.145
AFS-DR	0.177	0.560
AFS-DS	0.100	0.291
DR-DS	0.080	NS
AFS-DR-DS	0.430	NS

Table 4: Shelling percentage (%) of groundnut as influenced by agroforestury system. direction and distance at harvest.

DR/DS	Agroforestry system				
	GN	GN+T	GN+T+G	GN+T+Sb	Mean
DR-E					
DS 0-1	72.40	53.80	49.80	51.80	56.95
DS4-5	71.50	73.00	71.20	71.80	71.87
Mean	71.95	63.40	60.50	61.80	-
DR-W					
DS 0-1	71.90	56.30	53.20	55.10	59.12
DS4-5	73.30	75.00	73.30	73.80	73.85
Mean	72.40	65.65	63.25	64.45	-
DS					
DS 0-1	72.15	55.05	51.50	53.45	58.03
DS 4-5	72.60	74.00	72.25	72.80	72.86
Mean for AFS	72.27	64.52	61.87	63.12	-

For comparison of	S.Em±	CD 5%
AFS	0.108	0.346
DR	0.056	0.171
DS	0.038	0.112
AFS-DR	0.134	0.423
AFS-DS	0.077	0.223
DR-DS	0.068	NS
AFS-DR-DS	0.327	NS

Significant difference was observed in 100 kernel weight (Table 3) of sole groundnut and was lower in groundnut grown with teak, teak + grass and teak + subabul. Hundred kernel weight was significantly higher on western side as compared to eastern side. It was lower in 0-1 m distance from teak row as compared to 4-5 m distance from teak row. Groundnut grown with teak had recorded higher shelling percentage (Table 4) as compared to teak + subabul and teak + grass. Shelling percentage was higher on western side of teak row as compared to its eastern side.

Table 5: Harvest index of groundnut as influenced by agroforestry system, direction and distance at harvest.

DR/DS	Agroforestry system				
	GN	GN+T	GN+T+G	GN+T+Sb	Mean
DR-E					
DS 0-1	58.60	33.60	36.10	32.80	40.27
DS4-5	46.50	47.80	51.20	51.60	49.27
Mean	52.55	40.70	43.65	42.20	-
DR-W					
DS 0-1	55.10	29.70	35.90	41.90	40.65
DS4-5	48.00	47.20	49.60	48.90	48.42
Mean	51.55	38.45	42.75	45.40	-
DS					
DS 0-1	56.85	31.65	36.00	37.35	40.46
DS 4-5	47.25	47.50	50.40	50.25	48.85
Mean for AFS	52.05	39.57	43.20	43.80	-

For comparison of	S.Em±	CD5%
AFS	0.165	0.528
DR	0.110	NS
DS	0.137	0.400
AFS-DR	0.227	0.713
AFS-DS	0.274	0.800
DR-DS	0.176	0.685
AFS-DR-DS	0.810	NS

Lower shelling percentage was recorded at 0-1 m and significantly increased with distance from teak row (4-5 m). Harvest index (Table 5) was significantly higher in sole groundnut and lowest in groundnut with teak, teak + grass and teak + subabul. Direction effect was non-significant. Harvest index was lower in 0-1 m distance from teak row as compared to 4-5 m distance from teak row.

Inclusion of pastures along with teak row slightly reduced the groundnut yield as compared to teak row. The main reasons for decreased yield of groundnut in agroforestry system was due to severe competition for moisture and light by teak. Nadagoud (1990) working on effect of forest species on intercrop noticed reduction in groundnut growth and yield with teak (18.3%) and rose wood (18.4%) under irrigated agroforestry conditions. Among agroforestry systems, the extent of reduction in pod yield was 5.51 and 3.14 per cent in groundnut with teak and teak + subabul as compared to groundnut grown with teak + grass. Both pastures, competed for moisture and light. Similarly reduction in yields of maize, sorghum, sunflower and groundnut adjoining tree lines were reported by Chandrasekharaiah (1986), Itnal (1987), Bhat (1988), Nadagoud (1990) respectively.

The reduction in crop yield adjoining tree line might be due to the effect of shade from the tree species and their root competition with crops for moisture and nutrients. Low light intensity and soil moisture has adverse effect on crop growth resulting in reduction in the yield of groundnut nearer the tree line. Similarly, Nadagoud (1990) obtained lower yield of groundnut on eastern side of eucalyptus due to low light transmission ratio and low soil moisture as compared to western side. Teak row obstruct with westerly *kharif* rains, major part of rain falls on western side hence moisture content was higher on western side of teak row as compared to eastern side.

From the results obtained in the current study, it is inferred that yield reduction was more in teak + groundnut agroforestry system as compared to teak + grass + groundnut and teak + subabul + groundnut. Hence, we can summarize that groundnut can be grown as an intercrop in a teak based Agroforestry system.

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Journal
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Dual Responsibilities of Women Headed Households

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ABSTRACT

Data on 90 women belonging to divorce(30), widow(30) and migration(30) groups were interviewed with a developed schedule to study how the lone parenthood raises the family responsibilities of women. An important revelation of the study is that, "Home making" responsibility was 'most often' attended responsibility and "Social" responsibility was considered a 'rare' responsibility. Among child related responsibilities, "Discipline" was assumed 'most often' attended responsibility. As age of women and duration of headship increased the family responsibilities as well as stress were decreased. there were negative and substantial direct effects of age, income, family size, duration of headship increased. the family responsibilities as well as stress were decreased. There were negative and substantial direct effects of age, income, family size, duration of headship and occupation in order of importance on the family responsibilities of women. The direct effects of other variables i.e. number of children, education, gender role orientation and self-esteem were positive on the dependent variable i.e. family responsibilities.

Key words: Women Headed Household,Dual Responsibilities, Lone Parenthood, Self-esteem, Androgynous Personality,Stress.

In the absence of spouse, single women have to attend to all major responsibilities, that of parenting, managing the household and other responsibilities. This usually means that she has to work longer, harder and simultaneously at multiple jobs (Paterson, 1997); Women shoulder multiple responsibilities, acquire family management skills (Jetley, 1987); experience work overload (Dreman, *et al.*, 1997); double role burden.(Gulati, 1983; Gogate, 1986) as heads of households. Being head of the household, the entire responsibility of maintaining the household falls on her.

In addition to a higher work burden and lower incomes, female-head households also seem to suffer in terms of access to housing, credit, land and other resources. Much of the research has focused on economic consequences of living in female- headed households and ignored some of these other consequences. Hence, systematic data on other disadvantages suffered by female headed households remain limited (Desai and Ahma, 1998).

MATERIAL AND METHODS

The data on family responsibilities of women-headed families was collected from 90 women from Hyderabad city. The households constituted due to death (30), divorce(30) and migration of the husband (30) formed the sample. The research designs used were descriptive and diagnostic studies. Women were chosen based on four criteria such as women with one or more children, heading the household for at least 2 years and middle income with nuclear or extended nuclear families. A pre-tested interview schedule was used for the purpose of collecting data. Interview schedule developed for the study comprised of section on family responsibilities that had 2 sub-units 1) household and 2) child related responsibilities. Further household responsibilities were constituted by a) home making b) financial and c) social responsibilities. The section on child related responsibilities had a) education b) care and nurturing and c) discipline of children. Each sub-unit had statements measured on 3 point rating scale. 'Most often' (Mo) attended responsibility was given 3 points, for 'sometimes'(S) 2 points and 'rarely'(R) attended responsibility was given one point. There was no negative marking and stress related to responsibilities was also measured on 3 point rating scale. Information was gathered through direct interview method and required more than one sitting. The scores were analyzed using descriptive, mean difference, relationship, determination and path analyses.

RESULTS AND DISCUSSION

From descriptive analysis, it was observed that 72 per cent women were above 41 years age, 35.5 per cent have Ph.D degree, 44.4 per cent were in teaching profession and 40 per cent had monthly income above Rs.20,000. Forty four per cent had one child and fifty two per cent were employed and heading the families for 3 to 7 years. About 62 per cent had high self-esteem and 71 per cent had androgynous personalities (Table 1).

Table 1: Distribution of sample on the basis of family responsibilities and related stress.

Area of Responsibilities	Specific responsibilities	Frequency	Family Responsibilities		Relatd Stress	
			Number (N=90)	Percentage	Number (N=90)	Percentage
Household	Home making	MO	54	60.0	1	1.1
		S	33	36.6	30	33.3
		R	3	3.3	59	65.5
		Total	90	100.0	90	100.0
	Financial	MO	47	52.2	3	3.3
		S	37	41.1	40	44.4
		R	6	6.6	47	52.2
		Total	90	100.0	90	100.0
	Social	MO	28	31.1	8	8.8
		S	37	41.1	28	31.1
		R	25	27.7	54	60.0
		Total	90	100.0	90	100.0
Children	Education	MO	61	67.7	9	10.0
		S	16	17.7	29	32.2
		R	13	14.4	52	57.7
		Total	90	100.0	90	100.0
	Care and nurturing	MO	50	55.5	1	1.1
		S	37	41.1	40	44.4
		R	3	3.3	49	54.4
		Total	90	100.0	90	100.0
	Discipline	MO	65	72.2	6	6.6
		S	13	14.4	21	23.3
		R	12	13.3	63	70.0
		Total	90	100.0	90	100.0

The results on household and child related responsibilities reveal that majority of the sample (60.0%) accepted home making as 'most often' and 27.7 per cent subjects considered social responsibility taken up 'rarely'. Highest percentage of women (72.2%) considered discipline of children as a 'most often' attended responsibility. Higher per cent of women experienced stress 'rarely' for all the family responsibilities both household and children related responsibilities.

The mean difference analysis indicated that as age increased the scores on responsibilities decreased in the case of all the groups. However, the difference was not statistically significant. Widows have less stress, divorcees and migration group women have more stress from responsibilities. Groups differed significantly (P<0.05) in terms of education level and family responsibilities and related stress. Similarly, there was significant difference between the length of headship and family responsibilities and stress caused by responsibilities (P<0.05) but the groups did not differ statistically. Family responsibilities decreased as family size decreased for divorcee and migration groups, which was vice versa for widow group. There was significant difference found between the family size and stress related to family responsibilities.

Table 2: Correlation between psycho-social variables and study variables

Variable	Family responsibilities	Stress relatd to responsibilities
Age	-0.5244**	-0.3470**
Education	0.0408	-0.0456
Occupation	-0.0774	-0.1164
Duration of headship	-0.3430**	-0.1887
Income	-0.2776**	-0.0023
Family size	0.1365	-0.0127
Number of children	0.0367	-0.0077
Self esteem	0.1501	0.0264
Gender role orientation	0.1056	0.1242

** Significant at P<0.01

Table 3: Step down multiple regression analysis on family responsibilities

Variable	B-value (Rc)	SE of B	T value B
Age	-0.1817	0.0312	5.8177*
Education	0.6335	0.2001	3.1654*
Income	-0.4319	0.1662	2.5987*
No. of children	0.6061	0.2813	2.1540*

R^2 = 0.30742 F value = 12.7068
Intercept = 21.383

The study results reveal that women with higher responsibilities tend to have higher self-esteem (P<0.01) and the groups also differed significantly (P<0.05). Widows with high as well as medium self-esteem showed low stress from responsibilities when compared to women of other two groups. Divorced women with androgynous personalities perceived more stress.

The relationship between psycho-social variables and family responsibilities and related stress is described (Table 2).

A highly significant but negative correlation was found between age and family responsibilities and stress coming from family responsibilities. It indicates that with increase in age, the family responsibilities and related stress decreased. This correlation explains that younger women had more responsibilities and more stress while older women had fewer responsibilities and less stress. Experience of running household might have brought down the responsibilities and stress in women. Duration of headship and income showed negative but highly significant correlation with family responsibilities. It means that duration of headship and income were inversely related to the family responsibilities.

The determining variables of family

Table 4: Direct and indirect effects of personal social variables on family responsibilities.

Independent variable	Direct effects	Total indirect effects	Variables through which substantial indirect effects ae channelled	
Age	-0.5203	-0.0041	-0.1030	Income
			-0.0677	Duration of headship
			0.0644	Number of children
Number of children	0.4566	0.4199	-0.1833	Family size
			-0.0792	Gender role orientation
			-0.0779	Education
Income	-0.3240	-0.0464	-0.1654	Age
			0.1502	Education
			0.0529	Gender role orientation
Euducation	0.3195	-0.2787	-0.1523	Income
			-0.1113	Number ofchildren
			-0.1080	Age
Family size	-0.2495	-0.1130	0.3355	Number of children
			0.0932	Age
			-0.0454	Gender role Orientation
Gender role orientation	0.1619	0.0563	-0.2234	Number of children
			0.1612	Education
			-0.1058	Income
Duration of headship	-0.1369	-0.2061	-0.2571	Age
			0.0285	Education
			0.0441	Family size
Self-esteem	0.0241	0.1260	0.1274	Education
			0.0946	Gender role orientation
			-0.0879	Number of children
Occupation	-0.0009	-0.0765	0.2162	Education
			-0.1529	Age
			-0.0976	Income

responsibilities was found using step down multiple regression analysis (Table 3). The stronger determinants emerging from regression analysis were age, education, income and number of children. While age and income exhibited negative relation; education and number of children showed positive relation. Responsibility scores increased both while age and income scores decreased as well as when education and number of children increased. This significant relation could be explained as with increased age and income, family responsibilities came down. High income leads to added help in fulfilling responsibilities. Majority of respondents are working and earning, they might be seeking paid help and since they are single, kith and kin may help them.

In presentation of results of path analysis, the variables were arranged in the order of direct effects caused on the dependent variable from high to low. The three variables through which major substantial indirect effects are channeled were also listed in Table 4.

Age had the highest negative and substantial direct effect (-0.5203) on family responsibilities. There were negative and substantial direct effects of income, family size, duration of headship and occupation in order of importance on family responsibilities. Older women with more income and large family had lower family responsibilities. It can be inferred that older women means older children and large family also means more members, which may have resulted in sharing of family responsibilities. The direct effects of number of children, education, gender role orientation and self-esteem were positive. It can be concluded that more children means more responsibilities. The rationale of higher education leading to more responsibilities can be attributed to educated women taking up career and trying to succeed in job by compensating for the loss at home. Five variables namely education, age, number of children, income and gender role orientation had more substantial direct effects on family responsibilities. These may therefore be considered as most important in determining family responsibilities.

While age and family size had negative direct effects, number of children and gender role orientation had positive effects on stress related to responsibilities. It can be interpreted as older women would be more experienced in handling responsibilities leading to women perceiving low stress. Larger family means more people to share responsibilities therefore less stress for women. Women with more children and androgynous personalities have more stress because these women are conscious of varied responsibilities and hence perceive more stress.

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Journal
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Cotton a Boon Turned Bane - A Case Study

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ABSTRACT

The case study revelaed cotton crop a boon turned bane to a cultivator which took his life. Suicide is the act of intentionally ending ones own life. Leaving back the family members to suffer. Emphasized on balanced blending of indigenous technology as well as modern technology with maximinicun principle. Balanced thinking while taking decisions related to cotton crop cultivation and creating awareness towards balanced debts followed by inculcating problem solving skills.

Key words: Cotton, Maladies, Remedies

Cotton is the principal crop grown on a large area in Guntur district of Andhra Pradesh. Cotton suicidal deaths occurred due to many reasons, ambition to become progressive, to earn huge profits or improving their economy had motivated him to take the cotton farming. This was analyzed over a case study conducted in Tadikonda mandal of Guntur district with the respondents family about the suicidal cultivator named as Sri T. Sambaiah, whose crops were prone to failure since 4-5 years. So, mounting debts with private moneylenders and banks to such an extent that even after few successful crops, it is doubted difficult that he could clear if off. He could not feed his family and children and lost security in his abilities. His behaviour pattern, eating habits, relationships were also affected. He was psychologically affected and committed suicide.

MATERIAL AND METHODS

The method of exploring and analyzing the life of a social unit be it a person, a family, an institution or a community is known as a case study method. The case study technique has shown steady trend towards formalization, now be conducted in manner that the data are amenable to quantification and statistical treatment and are indispensable for therapeutic and administrative purpose. This was conducted in harmony with the improvement suggested to the case study.

Case study research design was followed in the present study. Guntur district was selected purposively. Tadikonda mandal was selected because of the identity of the case and the specific reason being the higher use of plant protection chemicals. Further the vulnerability of mandal towards suicidal deaths of cotton cultivators were demarcated by revenue authorities.

The data was collected primarily through informal discussions and interactions, coupled with semi structure interview schedule was used to avoid memory bias in eliciting information in the continuum from the family members of the deceased cultivators. Simple percentage and ranking were used. Afterwards, it was coded, classified tabulated and subjected for statistical analysis and graphical representation.

RESULTS AND DISCUSSION

Sri T.Sambaiah S/o. Sri Kotaiah resident of Bandarupalli village B.C cultivator aged 50 years, illiterate, living in joint family owned 1.5 acres dry land followed by cycle, radio, buffalo as material possession. He had a leased land of 2.5 acres costed his energies and landed him into debts. Added to it the death of his wife and son in an accident left him in a miserable condition. Further, the pressure from money lenders made him to sell the buffalo and 0.25 acres of the land at alarming low prices. This made him psychologically depressed. His dream / desire to purchase 5 acres of irrigated land ended in day dreams. With mounting debts, crop losses, pressure from money lenders, sense of hopelessness for future caused to commit suicide. Efforts were in vain through he has been lifted to hospital near by Guntur.

Critical maladies of cultivators it is special interest to begin with the observations about the critical maladies indicated by cultivators. Psychological maladies were sub-ranked as follows were fear compli, loneliness, depression, sense of helplessness, hopelessness for future. Family maladies observed were death of his wife and son and no moral support. Social maladies unpredictable weather conditions like rains, cyclones, drought assumed first rank followed by lack of organizational effort of farmers in the community to aid group / simultaneous

Table 1: Details of crops grown for last three years

Item	1st Year	2nd Year	3rd Year
Crops grown	Cotton	Cotton	Cotton
Expenditure incurred (Rs.)	52000	54000	56000
Annual income (Rs.)	21000	25600	186000
Net income (Rs.)	-31000	-28400	-37400
Debts (Rs.)			
a) Institutional	---	---	---
b) Private	90000	4500	4500
Over dues after crop period	---	---	---
Over dues as on date (Rs.)	---	13600	183900
Other expenditure incurred, if any (Rs.)	15000	15000	15000
Net over dues (Rs.)	136000	183900	2408000

The above Table 1 picturises the details of crops grown for last three years which includes expenditure incurred, annual income, net income, debts outstanding and the net over dues on date.

Table 2: Experience in Farming

Item	Response
Experience	8 years
Investment	Rs. 15500 / acre
No. of acres	4
Commercial crops cultivated	Nil
Investment on pesticides	Rs.5500
Investment on fertilizers	Rs.2000

The above Table 2 exhibits experience in farming, number of acres cultivated and investment on pesticides and fertilizers.

Table 3: Rank assignment of maladies

Item	Rank
Psychological	I
Family	II
Social	III
Support and service	IV
Technological	V

The ranks as perceived by the case respondents were given in accordance with their preferences of maladies in the Table 3 as Psychological denoted by Rank-1, Family with Rank II, Social Rank III, Support and Service Rank IV, followed by Te4chnological with least rank as Rank V.

Table 4: Psychological maladies.

Item	Response
Previous suicidal attempts	No
Any one committed / suicide among his	No
1. Friends	No
2. Neighbours	No
3. In his family	No
Relationships	No
Change(s) in his eating habits	Yes
Changes in his behaviour pattern	Yes
Sense of hopelessness	Yes
Prone for anxiety	
A) Physically	Yes
B)Mentally	
Suffered from	
a) Guilt	Frustration
b)Worthlessness	Yes
Insecurity about his abilities	yes
Depressed	Yes
Inflexible and rigid	Yes

The Table 4 expresses various psychological maladies comprising of awareness on suicides, relationship, changes in his eating habits, behavioural pattern, anxiety etc.,

action as may be necessary ranked second. Support and service maladies high cost of fertilizers and chemicals, mounting debts, high rate of interest for private money lenders, non-availability of money intime, low prices of farm produce, high labour charges beyond once capacity assumed rank I. II, III, IV, V and so on. Spurious pesticides, lack of quality control, non - availability of labour in time, non-availability of irrigation followed them. Technological maladies were sub ranked as given below with the figures in the parenthesis indicating the rank. Lack of knowledge about optimum utilization of pesticides and fertilizers (I) Lack of awareness of hazards from wrong use of pesticides (II) Lack of realization of dangers of monocropping (III) Lack of knowledge about IPM practices (IV).

Counselling centers, AO – technical support, banks and co-operative society – credit facilities. The government and the voluntary organization should concentrate more on propagating the prevention of suicides by cultivators through different media like television, radio, newspaper, exhibitions etc. To implement emergency number 108 in all districts, RMG support, soil testing laboratories, Regulated and assured supply of irrigation water to farmers during the crop season. Awareness programme on IPM need to be conducted. Price of farm produce expected to be fixed keeping the farmer's interest in view. Government should fix minimum support price (MSP) by taking into account the realistic cost of cotton cultivation. Efforts must e made to provide the required knowledge and skill through training programmes emphasizing the improved recommended technologies appropriate to all cotton farmers. The agriculture department need to provide subsidy on fertilizers, pesticides, plant protection equipment etc.,

Balanced blending of indigenous technology as well as modern technology with maximinicum principle. Balanced thinking while taking decisions related to cotton crop cultivation and creating awareness towards balanced debts followed by inculcating problem solving skills. Emphasized on systematic and advanced planning which includes using non-cash inputs, opting green manures, following correct season timely sowing and using IPM practices there by expenses on pesticides will be reduced were the lessons learnt.

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Journal
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Opinion and Suggestions on Radio Programmes by the Farmers of Warangal District in Andhra Pradesh

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ABSTRACT

A study was conducted in Warangal district of Andhra Pradesh to know the opinion and suggestions of farmers about radio programmes. Majority of the listeners had expressed their satisfaction over the present broadcast duration, suitability, timeliness, clarity, completeness and usefulness. Education, extension contact were positively significant with opinion of radio programmes at 0.01 level of probability and experience in farming , age were shown negatively significant relationship with opinion of the radio programmes at 0.05 and 0.01 level of probability, respectively.

Radio has become an effective and useful mass communication medium for transfer of new agricultural technology. It is the cheapest, fastest and farthest-reaching mass medium successfully cutting the barriers of literacy and distance. To broadcast effective programmes, systematic and periodic analysis of existing programmes is a must. Therefore, a study was conducted with the following specific objectives. To study the personal and socio-economic characteristics of the radio listeners. To know the opinion of radio programmes by the respondents. To un-earth the relationship between personal and socio-economic characteristics and opinion of radio programmes by the listeners. To know the most useful topics and suggestions of listeners about the radio programmes.

MATERIAL AND METHODS

The broadcast area of F.M AIR station, Warangal in Andhra Pradesh was purposively selected because no study was conducted earlier in this area. Out of fifty mandals three mandals viz., Geesugonda, Sangem and Hanumakonda were selected randomly for the study. Three villages from each of the three mandals were selected randomly viz., Elukurthy, Gangadevipally, Ookal, Katrapally, Gandhinagar, Chintapally, Mamnoor, Gadipally, Gunturpally. The study was conducted by using Expost-facto research design. A total of 45 respondents, who are having radio were selected purposively from the identified nine villages and interviewed during the year 2004.

Eleven independent variables- age, education, caste, occupation, experience in farming, family type, family size, size of land holding , annual income, social participation and extension contact were selected for the study and their relationship with opinion of radio programmes were tested by using arbitrary scoring procedure and correlation coefficients were workedout.

RESULTS AND DISCUSSION

An overview of Table 1, revealed that majority of the respondents were of 36-55 years age group, literates, backward class, medium level of experience, taking up farming as a sole occupation with > 2 ha of land holding, belongs to nuclear type of family with size of upto 5, having annual income of upto Rs. 50,000, with no membership in any organization and had medium level of extension contact.

Opinion of radio programmes by the respondents

The quality of message with regard to the frequency, transfer of farm information, type and mode of radio programmes, duration, suitability, timeliness, completeness, clarity and usefulness of radio programmes are shown in Table 2. 51.11 per cent of the respondents had regularly listening radio programmes, where as occasionally 42.22 per cent and rarely 6.67 per cent of the respondents listening the radio programmes. Majority 77.78 per cent of the respondents had the opinion that the farm information was transferred, where as the remaining 22.22 per cent opined that they were not transferred the farm information to any other farmers. With regard to the type of the programme 42.22 per cent respondents had listening agriculture + entertainment programmes followed by Agriculture + news 33.33 per cent agriculture programmes alone by 17.78 per cent and 6.67 per cent by agriculture+ rural and youth programmes. Regarding the mode of preference respondents opted first rank to live question and answer phone in programme followed by straight talk, announcement, interview with progressive farmers

Table 1 :Distribution of respondents according to their profile. N=45

Variable	Category	Frequency	Percentage
Age	<35 years	21	46.67
	36-54 years	23	51.11
	>5 years	1	2.22
Education	Illiterate	6	13.33
	Primary	16	35.56
	High school	11	24.44
	Intermediate	11	24.44
	Graduate	1	2.22
Caste	SC/ST	3	6.67
	BC	22	48.89
	FC	20	44.44
Occupation	Farming	40	88.89
	Farming + Agrl.Labour	2	4.44
	Farming + Caste occupation	-	-
	Farming + Business	2	4.44
	Farming + Service	1	2.22
Experience in farming	Low	5	11.11
	Medium	31	68.69
	High	9	20.00
Family type	Nucler	27	60.00
	Joint	18	40.00
Family size	Upto 5	27	60.00
	>5	18	40.00
Size of land holding	<1 ha.	5	11.11
	1-2 ha.	18	40.00
	>2 ha.	22	48.89
Annual income	Upto 50,000/-	37	82.22
	50001 -1,00,000/-	8	17.78
	>1,00,000/-	-	-
Social participation	No membership	32	71.11
	Membership in > one organization	13	28.89
Extension contact	Low	1	2.22
	Medium	33	73.33
	High	11	24.45

Table 2 : Distribution of respondents according to their opinion about the radio programmes.

Item	Category	Frequency	Percentage/ Rank
Frequency of use of radio	Regularly	23	51.11
	Occasionally	19	42.22
	Rarely	3	6.67
Farm information	Transferred	35	77.78
	Not transferred	10	22.22
Type of radio programme	Agriculture Programmes alone	8	17.78
	Agrl.+ Entertainment	19	42.22
	Agrl. + News	15	33.33
	Agrl. + Rural & Youth programmes	3	6.67
Mode of preference*	Live phone in programme	43	I
	Straight talk	32	II
	Announcement	27	III
	Interview with progressive Farmers	24	IV
	Quiz	12	V
Duration of the programme	Sufficient	32	71.11
	Not sufficient	13	28.89
Suitability of the programme	Most suitable	5	11.11
	Suitable	37	82.22
	Partially suitable	3	6.67
	Not suitable	-	-
Timeliness of the Programme	Always timely	26	57.78
	Some time timely	19	42.22
	Not timely	-	-
Completenessof the programme	Complete	28	62.22
	Some what complete	17	37.78
	Not complelte	-	-
Clarity of the programme	Always clear	24	53.33
	Some times clear	21	46.67
	Not clealr	-	-
Usefulness of the programme	Most useful	12	26.67
	Useful	33	73.33
	Not useful	-	-

* Mulltiple responses

and quiz.

With regard to the duration of the programme majority 71.11 per cent of the respondents had expressed the messages were sufficient, where as the remaining 28.89 per cent opined that the messages were not sufficient. Majority 82.22 per cent of the respondents had expressed the messages were suitable. Where as 11.11 per cent and 6.67 per cent listeners opined that messages were most suitable and partially suitable respectively. With regard to the timeliness of the message 57.78 per cent listeners had the opinion that the messages were always timely, where as the remaining 42.22 per cent opined that they were timely only occasionally. There was none with the opinion of always untimely.

The presentation of technologies was complete as far as majority (62.22%) of the respondents concerned. However, there were 37.78 per cent listeners with the opinion that the programme messages were somewhat complete. No one had expressed as not complete. The programmes were always clear to about half of the listeners (53.33%) and some times clear to 46.67 per cent of the listeners. No one had expressed as not clear. In nutshell, farm broadcast information were reported as useful by 73.33 per cent listeners and as most useful by 26.67 per cent . No one had expressed as not useful. Nataraju (1997), Sarwamangala *et al.*, (1999), Senthivel Murgan and Manoharan, (1995) also reported similar findings.

Rational analysis

The relationship between opinion of the radio programmes and selected independent variables shown in Table 3, reveals that education, extension contact were positively significant with opinion of radio programmes at 0.01 level of probability and experience in farming, age were negatively significant relationship with opinion of the radio programmes at 0.05 and 0.01 level of probability, respectively.

Table 3: Relationship between opinion of radio programmes and profile of the respondents.

Independent Variable	'r' value
Age	-0.562**
Education	0.458**
Caste	0.252 NS
Occupation	0.138 NS
Experience in farming	-0.327*
Family type	-0.111 NS
Family size	-0.148 NS
Size of land holding	0.168 NS
Annual income	0.156 NS
Social participation	0.157 NS
Extension contact	0.547**

* 0.05 Level of probability

** 0.01 level of probability

Table 4: Most useful topics of agricultural programmes braodcasted through AIR Warangal

N=45

Topics	Frequency	Percentage
Chilli pests and diseases control	45	100.00
Paddy pests and diseases control	45	100.00
Importance of green manuring	45	100.00
Weather forecasting	45	100.00
Market rates	45	100.00
Rice panicle mite control	37	82.22
Cotton bollworm control including IPM practices	35	77.78
Paddy nursery management	34	75.56
Pulses cultivation practices	34	75.56
5% NSKE preparation	32	71.11
Paddy varieties and water management	32	71.11
Rabi I.D Crop management	31	68.89
Maize seed treatment and plant protection	28	62.22
Turmeric diseases control	27	60.00
Fodder storage	25	55.56

Most useful topics of agricultural programmes broadcasted through AIR, warangal

A perusal of the Table 4 indicates that the respondents reported a total of fifteen most useful topics of agricultural programmes broadcasted through AIR, Warangal of the, five topics were quoted by the cent per cent of the respondents viz., importance of green manuring chilli pests and diseases, paddy pests and diseases, market rates and weather forecasting.

In addition to the above, 55.56 to 82.22 per cetn of the respondents expressed the following topics viz., rice panicle mite control, cotton bollworms control including IPM practices, paddy nursery management, pulses cultivation practices. Paddy varieties and water management, 5 per cent NSKE preparation, rabi I. D crops management, maize seed treatment and plant protection, turmeric diseases control and fodder storage.

Implications for improvement

- Majority of the radio listeners suggested the following to improve the radio programmes quality.
- More live phone in programmes may be broadcasted.
- Live phone in programmes must be given to experienced scientists only.
- Linkage with Agricultural Research Station, D.A.A.T.T. Centre, Department of Agriculture, Department of Horticulture, Department of Animal Husbandry, Department of Sericulture and NGO's in the proramme planning.
- During live phone in programme give chance to more number of farmers.
- Increase the duration of morning agriculture programmes
- Progressive farmers involvement in the broadcasting may be increased.
- Broadcasting of information in local dialect.

An overview of the findings indicated that majority of the respondents have expressed their satisfaction over the present radio programmes with regard to the frequency of use of radio, transfer of farm information, type and mode of radio programmes, duration, suitability, timeliness, clarity, completeness and usefulness. There is need for improving the present radio programmes to the most satisfactory level by concentrating the unwillingness parameters of the opinion expressed by the meagre percentage of respondents.

Further, live question and answer phone in programme, straight talk, announcement, interview with progressive farmers and quiz may be frequently used as they were found to be the most preferred modes.

Similarly, the administrators and extension workers who are concerned with All India Radio and Agricultural Department make use of the positive and significantly related characteristics and suggestions of radio listeners for effective broadcast of quality radio programmes.

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Journal
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Perception of Drudgery of Rural Women in Farm Activities

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ABSTRACT

The present investigation was carried out in Srikakulam district of Andhra Pradesh with a major objective to study the perception of drudgery of farm women in farm activities. Three mandals out of 37 mandals in the district were selected randomly for the study. A total of 120 farmwomen comprising of 60 landless labourers and 60 family labourers were selected for the study. The results on perception of drudgery revealed that the farmwomen perceived drudgery in many of agricultural operations carried out by them.

Women play a significant and crucial role in agriculture and allied sectors . The prosperity and growth of the nation depend on the status and development of its women. Women in India constitute nearly half of its population. Women spend long hours with much labour in respective operations resulting in fatigue and drudgery.

As cultivators, agricultural labourers, artisans and housewives, they constitute sizable section of work force. Their contributions in agriculture are roughly estimated to be around 50 per cent. They contribute as cultivators and labour are engaged in number of operations with men independently and jointly. The participation of women varies from carrying out actual farm operations in the fields to supervision, management and decision making in different actual operations. Therefore, the life of women is full of drudgery at every stage. the present investigation made an attempt to study the perception of drudgery of rural women in farm activities.

MATERIAL AND METHODS

The study was conducted in Srikakulam district of Andhra Pradesh. Three mandals out of 37 mandals in the district were selected randomly for the study. A total number of 6 villages, comprising 2 villages from each mandal were selected for the study. A total of 120 farmwomen comprising 60 landless labourers and 60 family labourers were selected for the study. From the district statistics it was observed that paddy is the major crop grown in the district. By keeping this in view the participation of women in paddy cultivation was taken for the study for perception of drudgery in farm activities. Statistical methods like frequency, percentages and Z-test were used to analyze the data.

RESULTS AND DISCUSSION

In nursery management, though the participation of women is low, majority (74.16%) of the farmwomen perceived medium drudgery. Where as a higher percentage of family labour perceived it as more drudgery, when compared with landless labour. Hence, a significant difference was noticed between the two categories of farmwomen in their perception of drudgery, regarding this activity. This might be due to family labour played supportive role in nursery management. So they perceived more drudgery in these activities. In contrast, the landless labour did not participate or low participation in this activity and perceived as less drudgery ridden (Table 1).

Transplantation was perceived as more drudgery by (82.5%) of the respondents in the pooled sample. This might be due to bending for long hours in mud while transplanting they subjected to strain. But a greater percent among landless labours perceived it as more drudgery prone; hence a significant difference was noticed between the two categories regarding the practice.

Cent percent of the respondents perceived fertilizer management as less drudgery prone activity. Where as 93.30 percent of the respondents perceived plant protection as less drudgery prone activity. A significant difference in the perception of drudgery between the two categories of the rural women at 0.01 level of probability on the fertilizer management. This might be because family labour felt some kind of health hazards due to inhalation of pesticides while preparing the solution. Where as landless labourers, had low participation and perceived it as less drudgery.

Weeding in the main field was one of the practices, which the two categories of farmwomen

Table 1: Extent of perception of drudgery of farmwomen in farm (paddy cultivation) activities.

Farm activity	Perception of drudgery								
	Landless labourers (n=60)			Family labourers (n=60)			Total (n=120)		
	More	Medium	Less	More	Medium	Less	More	Medium	Less
Nursery management	4 (6.66)	41 (34.16)	15 (12.50)	14 (23.33)	48 (80.00)	2 (3.33)	18 (15.00)	89 (74.16)	17 (14.16)
Transplanting	59 (96.67)	2 (3.33)	0 (0.00)	41 (68.30)	15 (23.33)	4 (6.66)	99 (82.50)	17 (14.16)	4 (3.33)
Fertilizer management	0 (0.00)	0 (0.00)	60 (100.00)	0 (0.00)	14 (23.33)	46 (76.66)	6 (5.00)	14 (11.66)	106 (88.33)
Weeding	28 (46.67)	30 (50.00)	2 (3.33)	26 (43.33)	21 (35.00)	13 (21.66)	54 (45.00)	51 (42.50)	15 (12.50)
Plant protection practices	2 (3.33)	2 (33.00)	56 (93.30)	12 (20.00)	11 (18.33)	37 (61.66)	14 (11.66)	13 (10.83)	93 (77.50)
Harvesting	60 (100.00)	0 (0.00)	0 (0.00)	60 (100.0)	0 (0.00)	0 (0.00)	120 (100.00)	0 (0.00)	0 (0.00)
Post-harvesting Practices	18 (30.00)	33 (55.00)	9 (15.00)	10 (16.67)	35 (38.33)	15 (25.00)	28 (23.33)	68 (56.66)	24 (20.00)
Total farm (Paddy cultivation) activities	5 (8.33)	43 (71.66)	12 (20.00)	10 (16.67)	35 (38.33)	15 (25.00)	28 (23.33)	68 (55.66)	24 (20.00)

Figures in parentheses indicate percentages

did not differ in their perception of drudgery. This might be due to the reason that, majority of the landless labourers and family labour had medium extent of farm of participation in weeding and they sit on for long hours for weeding.

Harvesting was one of the practices, which cent per cent of the total respondents felt more drudgery-ridden activity. Majority (56.66%) perceived medium extent drudgery in post-harvesting practices. The reasons for this might be that, required bending posture for long hours, required energy to hold a bunch of plants by one hand and cutting them with another hand.

Majority of farmwomen perceived post-harvesting practices as medium to more drudgery. The reason that could be attributed to such a trend could be, the post-harvesting practices, making bundle of the produce, carrying head loads were perceived as more drudgery prone, it involves strenuous movements of neck and physical strain. The two categories of women did not differ in their perception of drudgery regarding this practice.

Table 2 :Difference between two categories of farmwomen in perception of drudgery in farm (paddy cultivation) activities.

S.No	Farm activities	Mean Participation of drudgery		
		Landless labourers	Family labour	'Z'Values
1	Nursery management	6.57	7.16	12.00**
2	Transplanting	2.93	2.55	6.54**
3	Fertilizer management	1.00	1.23	4.02**
4	weeding	2.46	2.21	1.29NS
5	Plant Protection	1.06	1.58	2.90**
6	Harvesting	3.00	3.00	0.00NS
7	Post-harvesting practices	13.41	13.31	1.62NS
8	Total paddy cultivation	29.42	13.10	3.03

** Significant at 0.01 probability level. NS= Non significant

The results on perception of drudgery revealed that the farmwomen perceived drudgery in many of agricultural operations carried out by them. Hence, there is a need to develop appropriate, simple and easy to use implements to help the farmwomen for reducing their drudgery.

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Constraints Faced by the Growers in Hybrid Rice Cultivation

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ABSTRACT

The study was conducted in 14 villages of two blocks in Khurda district of Orissa. Information was collected personally from 104 rice growers through a structured schedule. It is observed that the farmers faced constraints in ecological, technological, input supply, extension-support and policy considerations. The important constraints such as quality seeds of required variety, input availability with price support, training, demonstration and regular guidance, credit facilities, easy disposal of produce with remunerative price needs consideration for popularization and area expansion under hybrid rice.

Hybrid rice is an innovative technology in Indian agriculture holding great promise to sustain the self-sufficiency in rice production. To exploit the full potential of F_1 hybrids in cultivation, adoption of recommended package is a prerequisite. Rice itself requires adoption of various practices such as water management, disease and pest management as well as inter-cultural operations. Effective transfer of technology at different levels play a vital role in developing competency of the growers. Marketability of the produce is another consideration in commercial cultivation. Therefore, constraints faced by the growers in hybrid rice cultivation.

MATERIAL AND METHODS

The study was undertaken in Balipatna and Balianta blocks of Khurda district in Orissa during 2006. A sample size of 104 rice growers from 14 villages were randomly selected and personally interviewed with a structured schedule pre-tested earlier. Collected information were analyzed.

RESULTS AND DISCUSSION

Constraints related to ecological condition, technological aspects, input availability, extension support and policy considerations were selected for the study, which were analyzed separately.

Rice grown in diversified ecological conditions having wide variation in soil, climate, rainfall and temperature. The ecological constraint faced by the growers in hybrid rice cultivation is presented in Table 1.

Adverse climate has been considered as the most important constraint followed by insufficient rainfall. Rice is grown depending on rainfall during *kharif* and irrigated condition in summer. Insufficient water may not be that problematic unless there is drought. Similarly, adverse climatic condition is not a regular phenomenon. Insufficient water and adverse climatic condition therefore occasional and not to be considered as important constraints as farmers are growing rice both in kharif and summer season. On the whole, there is not much of ecological constraints in hybrid rice cultivation.

Table 1 : Ecological constraints in hybrid rice cultivation

Constraint	Percentage				
	Very important	Important	Not important	Mean score	Rank
Nursery raising	30.77	26.92	42.31	1.88	IV
Proper pudding	32.64	29.89	37.50	1.95	III
Insufficient water	42.31	46.15	11.54	2.31	II
Adverse climate	57.67	42.31	-	2.58	I
Unhealthy soil	57.70	13.46	78.84	1.13	V

Hybrid rice cultivation is more sophisticated than usual rice cultivation. The growers have to be equipped with necessary skills particularly in nursery raising, transplanting and other cultural management. The growers did not face any important technological constraints in hybrid rice cultivation as appeared in Table 2. Since hybrid rice is high yielder, naturally it requires more fertilizers and occurrence of disease and pest for which the grower has to take all possible measures. Unavailability of choiceable variety as reported by 84.62% is definitely a constraint which has to be taken care.

Easy availability of inputs with fair price often motivate farmers to adopt new technologies. It is observed from the Table 3 that poor quality and untimely availability of inputs were the major constraint faced by the growers in hybrid rice cultivation. These two

Table 2 : Technological constraints in hybrid rice cultivation.

Constraint	Percentage Very important	Important	Not important	Mean score	Rank
Non availability of required variety	48.08	36.54	15.38	2.33	I
More disease & Pest attack	36.54	44.23	19.23	2.17	III
Severe weed infestation	19.23	38.46	42.31	1.77	IV
Requires more fertilizer	42.31	46.15	11.54	2.31	II
Insufficient skill to manage	26.92	23.08	50.00	1.77	IV

Table 3 : Constraints on supply of inputs.

Constraint	Percentage Very important	Important	Not important	Mean score	Rank
Poor quality	48.08	42.31	9.61	2.38	II
Untimely availability	53.85	41.31	4.81	2.49	I
Unreasonable price	23.08	19.23	57.69	1.65	III
No custom hiring of implements	17.31	23.08	59.61	1.58	IV
Distance place	7.69	34.62	57.69	1.50	V

Table 4 : Constraints faced by the growers on extension suport

Constraint	Percentage Very important	Important	Not important	Mean score	Rank
Insufficient training	46.15	48.08	5.77	2.40	I
Inadequate demonstration	38.46	47.12	14.42	2.24	II
No exposure visti	26.92	34.62	38.46	1.88	IV
Lack of technical guidance	32.70	46.15	21.15	2.11	III
Inadequate supply of literature	26.92	42.31	30.77	1.67	V

Table 5 : Constraints on policy suport

Constraint	Percentage Very important	Important	Not important	Mean score	Rank
No price support for inputs	46.15	47.12	6.73	2.39	III
No incentives to motivate	36.54	44.23	19.23	2.17	V
No crop insurance	26.92	34.62	38.46	1.88	VI
Insufficient credit facility	57.69	31.73	10.58	2.47	II
Lack of easy disposal of produce	42.31	46.15	11.54	2.36	IV
Non-remunerative price	57.69	42.31	-	2.58	I

Table 6: Comparative analysis of various constraints

Constraint	Mean score	Average
Ecological	2.18	0.20
Technological	2.07	-0.09
Input supply	2.03	-0.13
Extensionsupport	2.18	0.02
Policy consideration	2.30	0.14
Average	2.16	-

were also pertinent factors in popularization of any innovations.

Transfer of technology is another important dimension, which exposes the individuals to the technological developments and enriches the knowledge as well as skill competency of the growers. But it is observed from the investigation (Table 4) that insufficient training, inadequate demonstration and lack of technical guidance were the major constraints faced by the growers in hybrid rice cultivation. Demonstration is conducted to develop confidence on feasibility of the technology and learn skills. Training enriches knowledge and skill. Advisory services helps in management of various operations. When all these extension support were not provided, hybrid rice cultivation cannot be popularized and restrict the area expansion.

Hybrid rice cultivation usually cost expensive. It is risk oriented due to adverse weather condition, epidemic in pest and disease attack and disposal of produce with remunerative price. The growers therefore need some policy support of the Government . The constraints faced in this regard indicated that (Table 5) the growers demanded all most all the support indicated in the Table.

Out of these credit facilities, disposal with remunerative price, price support for crop inputs and easy disposal of produce definitely need consideration.

Comparative analysis of the constraints indicated that (Table 6) the rice growers faced constraints in all most all aspects in hybrid rice cultivation and more in policy consideration, extension support and ecological condition. Attempt was also made to correlate the socio-economic variables with adoption level as reflected in Table 7. It is observed that extension contact, holding size, farm implements possession and annual income positively and age negatively influenced adoption of hybrid rice.

The findings of the study conclude that :

1. The farmers faced constraints in almost all aspects of hybrid rice cultivation and constraints in policy as well as extension support were more in comparison to others.

2. Among the constraints, availability of quality seeds of require hybrid timely availability of inputs with price support, training to upgrade knowledge and skills, demonstration, proper advisory services, credit facility, easy disposal of produce within remunerative price needs

Table 7 : Influence of socio-economic varibles on adoption

Variables	Correlation value	Test of significance value
Age	-0.219*	2.266
Education	-0.087	0.882
Caste	0.036	0.364
Extension contact	0.383**	4.168
Holding size	0.397**	4.214
Possession of farm implements	0.345**	3.667
Annual income	0.648**	8.589

* Significant at 0.05 level, ** Significant at 0.01 level

consideration for popularization and area expansion under hybrid rice cultivation.

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Growth Comparisons of Turmeric upto 2020 AD

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ABSTRACT

Studies undertaken to measure the growth rates of turmeric and to estimate the future projections up to 2020 AD by using the regression equations, revealed that turmeric production would increase considerably in Andhra Pradesh and India.

Key words: Turmeric, Growth Comparisons

Turmeric (*Curcuma longa* L.) is one of the most important spice crops of India and belongs to the family *Zingiberacee.* It is cultivated in an area of 185.32 lakh hectares with a production of 701.66 lakh tones, supplying 94 per cent of the world's demand. Pakistan and Bangladesh are the other major producers. Andhra Pradesh is producing 375.77 lakh tones in an area of 73.93 lakh hectares. Tamil Nadu follows with 33 lakh hectares with 158.64 lakh tones. Turmeric contains about 69.43 per cent carbohydrates, 6.30 per cent proteins, 5.10 per cent oil and 3.60 per cent minerals and other important elements. United Arab Emirates (UAE) is the major importer accounting for 24.06 per cent followed by United States of America (USA) with 12.93 per cent. The 2003-04 India exported 34500 tonnes of turmeric. It is intensively grown in the high land with sandy loam soils. Many studies have been undertaken to estimate the growth rates of area, production and productivity of various crops, Martin and Yeh (1965) and Ahuja (1987).

In this paper an attempt has been made to assess the growth rates in the area, production and productivity of turmeric in Andhra Pradesh and in India over a period of 35 years from 1970 to 2004. Besides, growth rates the projections were also estimated upto 2020 AD.

MATERIAL AND METHODS

The data of the present study for a period of 35 years (1970-2004) in Andhra Pradesh in comparison with India pertaining to area, production and productivity of turmeric were collected by the said period from various publications, journals and websites.

Different functions were tried and the function which is having least residual mean sum of square was selcted as appropriate for the projections. The linear, quadratic, exponential, logarithmic, inverse and compound equations were fitted.

Linear : $Y = a+bt$

The linear growth rate was calculated by the formula $\frac{b}{y} \times 100$

Quadratic : $Y = a + bt + ct^2$
Exponential : $Y = a.b^t$
The linear growth rate was calculated by the formula $(b-1) \times 100$

Logarithmic $y = a + b \log t$

Inverse : $y = a = \frac{b}{t}$

Compound : $y = a + b^t$

Where t is independent (time and Y is dependent variable. a, b and c are constants for the above equations.

RESULTS AND DISCUSSION

The data on linear, quadratic exponential, logarithmic, inverse and compound regression equations were fitted and the parametric values are presented in Table 1.

It is found that the linear regression equation is the best fit of its highest coefficient of determination. Hence, the future projections of area, production and productivity of turmeric in Andhra Pradesh and India were calculated based on the Linear regression equation and are presented in Table 2.

The results revealed that the turmeric production in India may reach to 959 lakh tonnes in 2020 and the productivity is also increasing from 4576 kg ha^{-1} to 5952 kg ha^{-1}. In Andhra Pradesh it increases from 5759 kg ha^{-1} to 7461 kg ha^{-1}, which is very high as compared with the Indian productivity.

Turmeric (*Curcuma longa* L.) is the major spices having high commercial value in India especially in Andhra Pradesh. The study reveals that acreage of the turmeric crop is increasing day by day which is due to the demand in the international market of its medicinal values. The projected area, production and productivity showed that all the factors are in continuous positive trend both at state and country level in conformity with Ahuja (1987).

Table 1: The parametric values in regression equations of area, production and productivity of turmeric in Andhra Pradesh snd India.

	Linear	Quadratic	Exponential	Logarthmic	Inverse	Compound
			ANDHRA PRADESH			
Area						
a	9.1695	5.444	2.738	-2.678	43.121	15.470
b	1.6960	4.353	0.046	15.780	-41.380	1.047
c		-0.109				
R²	0.960	0.950	0.860	0.580	0.190	0.860
Production						
a	-27.5627	11.020	3.464	-102.733	192.844	31.970
b	10.9840	8.484	0.077	101.610	-271.782	1.080
c		0.010				
R²	0.9100	0.160	0.900	0.547	0.184	0.900
Productivity						
a	1788.1230	604.055	7.633	813.148	4126.906	2066.799
b	113.4530	539.639	0.031	1126.590	-3309.590	1.030
c		-15.964				
R²	0.9200	0.850	0.770	0.555	0.220	0.770
			INDIA			
Area						
a	61.1200	20.890	4.201	42.480	115.340	66.817
b	2.9800	19.550	0.028	25.818	-68.913	1.029
c		-0.706				
R²	0.9000	0.840	0.890	0.660	0.250	0.89
Production						
a	34.8200	38.340	4.660	-65.510	366.520	79036.000
b	18.4800	34.020	0.062	153.660	-39.000	1.060
c		-0.802				
R²	0.9800	0.950	0.870	0.550	0.190	0.870
Productivity						
a	1366.7400	535.990	7.366	861.980	3013.420	1581.740
b	91.7000	478.660	0.033	765.230	-1984.930	1.033
c		-16.850				
R²	0.9600	0.830	0.800	0.520	0.180	0.800

Table 2: Projections of area, production and productivity of turmeric in Andhra Pradesh and India.

Year	Area in lak ha	Produc-tion lakh tonnes	Produc-tivity kg ha^{-1}	Area in lak ha	Produc-tion lakh tonnes	Produc-tivity kg ha^{-1}
	ANDHRA PRADESH				I N D I A	
2005	69	357	5759	165	682	4576
2006	70	368	5872	168	700	4668
2007	72	379	5986	171	719	4760
2008	74	390	6099	174	737	4851
2009	75	401	6213	177	756	4943
2010	77	412	6326	180	774	5035
2011	79	423	6440	183	793	5126
2012	80	434	6553	186	811	5218
2013	82	445	6667	189	829	5310
2014	84	456	6780	192	848	5402
2015	85	467	6894	195	866	5493
2016	87	478	7007	198	885	5585
2017	89	489	7120	201	903	5677
2018	91	500	7234	204	922	5768
2019	92	511	7347	207	940	5860
2020	94	522	7461	210	959	5952

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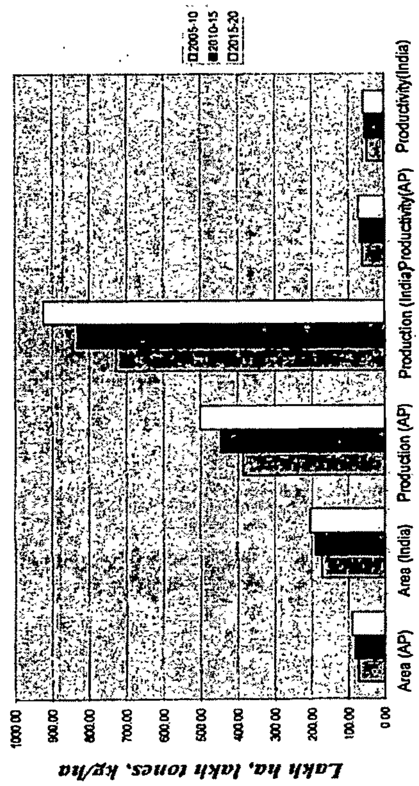

Projections of area, production and productivity of turmeric in Andhra Pradesh and India from 2005 to 2020

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Journal
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Research Note

Effect of New Post Emergence Herbicides on Nutrient Uptake by Rice-fallow Blackgram [*Vigna mungo* (L.) Hepper] and Associated Weeds

Key words: New Post-emergence Herbicides, Rice-fallow

Weeds usually grow faster than crop plants and thereby absorb the available nutrients earlier resulting in reduced availability to crop plants. Nutrient uptake of N, P and K by blackgram and associated weeds grown under upland conditions under different weed control measures was well documented. However, studies on the effect of different new generation herbicides on nutrient uptake by blackgram and associated weeds under rice-fallow situation are limited. Therefore, the present investigation was carriedout to study the effect of different new post-emergence herbicides on the uptake of nitrogen, phosphorus and potassium by rice-fallow blackgram and its associated weeds.

A field experiment was conducted during *rabi* 2002-03 at the Agricultural College Farm, Bapatla. The soil of the experimental field was sandy clay loam in texture with pH of 7.9 and was low in available nitrogen (206 kg ha^{-1}), available phosphorus (21 kg ha^{-1}) and high in available potassium (391 kg ha^{-1}). The experiment consisted of seven treatments (Table 1), was laid out in randomized block design with four replications. The sprouted seeds of blackgram (LBG 645) were broadcasted in the standing rice crop two days before harvest. Sandmix application of benthiocarb was done seven days after sowing (DAS) of blackgram and followed by water spray after the removal of paddy sheaves as pre-emergence application. The post-emergence herbicides were applied at 15 DAS using a spray volume of 500 l ha^{-1} . The crop did not receive any irrigation and survived entirely on residual moisture and fertility only. The preceding rice crop received a fertilizer dose of 120:60:60 kg ha^{-1} of N, P_2O_5 and K_2O, respectively.

Weed flora of the experimental field consisted of *Echinochloa colonum, Echinochloa crusgalli, Leersia hexandra, Panicum repens, Cyperus rotundus, Cyperus kyllinga, Eclipta alba, Grangea maderaspatana, Cardanthera uliginosa, Xanthium strumarium, Ammannia baccifera and Commelina benghalensis.*

Data were collected as per standard procedures. All the herbicidal treatments significantly influenced drymatter accumulation and nutrient uptake by weeds and crop (Table 1). Concentration of N, P and K did not show much variation under different treatments, so the uptake of nutrients by crop and weeds under different treatments were related to the amount of drymatter production. Among the herbicide treatments, post-emergence application of imazethapyr at 63 g ha^{-1} had minimum depletion of N, P and K by weeds and maximum uptake by blackgram and was comparable to hand weeding at 15 and 30 DAS in case of crop uptake but significantly lower than hand weeding in case of nutrient depletion by weeds. This treatment is also on a par with rest of the herbicide treatments. The minimum nutrient depletion by weeds in these treatments was owing to minimum weed drymatter produced as a result of effective weed control. Hand weeding at 15 and 30 DAS had the lowest nutrient depletion by weeds and highest uptake by crop among all the treatments.

The minimum uptake of these nutrients by crop was observed in unweeded check. It can be attributed to lower crop drymatter production and low availability of these nutrients to crop as major amount of these nutrients were depleted by weeds. This shows the importance of keeping the crop free from weeds to enable the crop to absorb more nutrients from the soil. From the data, it can be summarized that post-emergence application of imazethapyr at 63 g ha^{-1} applied at 15 DAS can keep an effective check on nutrient depletion by weeds in rice-fallow blackgram, in agreement with Rao and Murthy (2004).

Table 1 : Effect of different treatments on drymatter accumulation and nutrient uptake by rice-fallow black gram and its associated weeds

Treatments	Dose kg ha^{-1}	Time of aplication (DAS)	Weed dry weight (Kg ha^{-1}) at harvest	Nutrient depletion by weeds *kg ha^{-1}) at harvest			Crop dry weight at harvest (kg ha^{-1})	Seed yield (kg ha^{-1})	Nutrient (uptake by crop kg ha^{-1}) at harvest		
				N	P	K			N	P	K
Unweeded check	--	--	6.92 (1070.61)	18.3	6.0	29.3	1075	550	30.5	4.7	17.9
Hand weeding	--	15&30	4.27 (102.68)	1.5	0.6	3.2	2140	1126	61.3	11.5	40.2
Benthiocarb	2000	7	6.11 (372.91)	4.3	2.2	6.4	1783	922	55.8	8.7	29.7
Imazethapyr	63	15	5.88 (372.91)	4.1	1.6	6.0	1801	930	56.6	9.2	33.3
Fenoxaprop ethyl	56	15	6.07 (496.91)	4.7	2.3	7.4	1669	832	51.5	7.7	25.4
Clodinafop propargyl	52	15	6.2 (516.36)	5.1	2.5	7.9	1661	827	50.7	7.5	24.4
Cyhalofop butyl	100	15	6.13 (468.16)	4.4	2.1	6.9	1775	876	53.5	8.0	29.0
CC (P=0.05)	--	--	0.65	0.6	0.9	1.5	294	165	7.8	1.7	7.9

DAS=Days after sowing. In case of weed dry weight data were transformed to log y+1 transformation. Original values are given in parentheses.

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Research Note

Effect of Different Levels of Nitrogen and Potasium on Transplanted Chilli

Key words: Potassium, Chillies

Chilli (*Capsicum annuum* L.) is an important commercial crop of Andhra Pradesh. It is used both as a vegetable and a condiment in the daily diet. Chilli is popularly called as red pepper or hot pepper. It is grown in an area of 2.7 lakh ha in the state. The farmers of Krishna-Godavari Zone use very high doses of chemical fertilizers with improper nutrient balances which has led to high pest and disease incidence, nutrientional disorders and deterioration in productivity. A balanced nitrogen and potassium fertilizer schedule for transplanted chilli under irrigated dry conditions is perhaps the most important management practice for successful production of chilli and hence, the present study was taken up.

A field experiment was conducted at Regional Agricultural Research Station, Lam during *Kharif*, 2001-2002. The soil of the experimental site was slightly alkaline in reaction with 8.0 pH, EC of 0.25 dsm^{-1} with available nitrogen of 189 kg ha^{-1}, available phosphorous of 36 kg ha^{-1} and exchangeable potassium of 275 kg ha^{-1}. It was conducted with four levels of nitrogen (0,100,200,300, kg ha^{-1}) and four levels of potassium (0,40,80 120 kg ha^{-1}) with three replications in randomized block design with factorial concept. A high yielding variety LCA 334 was transplanted with inter- and intra- row spacing of 60 x 30 cm. The entire recommended dose of phosphorus (60 kg ha^{-1}) was applied as basal dose. Nitrogen and potassium were applied as per the treatments in four split doses. Recommended management practices were followed . Data were recorded on plant height, days to 50% flowering, 100 pod weight, fruits per plant and dry chilli yield.

Application of graded levels of nitrogen and potassium significantly increased the yield attributes and yield in chilli. Yield response to graded levels of nitrogen and potassium was linear. Among the nitrogen levels 300 kg N ha^{-1} recorded significant increase in plant height (74.4 cm) and number of fruits per plant (301.8), compared to control which recorded the lowest plant height (66.68 cm) and number of fruits per plant (147.2) (Table). The treatment N 300 kg ha^{-1} recorded significant increase in 100 pod weight (36.2g) and there by yield (3920 kg ha^{-1}) over control which recorded the lowest 100 pod weight (33.3g) and yield (1280 kg ha^{-1}) . Increased uptake of nutrients might have enabled the plant to put up greater growth leading to more number of fruits per plant as reported by Srinivasan *et. al.* (1999) Medhi *et. al.* (1990) and Maya *et. al.*, (1997). Such increase in yield might be due to increased availability of N causing accelerated photosynthetic rate thus leading to more production of carbohydrates.

Among the potassium levels, significantly highest plant height (73.52 cm), number of fruits per palnt (257.67) and dry chilli yield (3056 kg) was recorded at 120 kg K_2O ha^{-1} when compared to the lower levels of potassium application. This might be due to the action of potassium as a growth promoting substance which resulted in production of more number flowers and fruit set. Medhi *et al* (1990) reported similar results. Interaction effects were non significant. The response of chilli crop to nitrogen and potassium fertilization showed that there was significant increase in plant height, number of fruits per plant, 100 pod

Table: Effect of nitrogen(N) and potassium (K) on yield attributes and yield in chilli (Mean of 2001 and 2002).

Treatments	Plant height (cm)	Days to 50% flowering	No. of fruits/ plant	100 pod weight (g)	Dry chilli Yield (kg ha^{-1})
Nitrogen levels					
N_0	66.68	51.9	147.2	33.3	1280
N_{100}	70.65	52.3	163.0	33.6	1580
N_{200}	72.86	52.6	216.4	34.2	3140
N_{300}	74.44	52.7	301.8	36.2	3920
CD(P=0.05)	3.12	NS	14.57	1.08	338
Potassium levels					
K_0	71.03	52.5	155.0	33.6	1822
K_{40}	69.87	51.8	187.3	34.2	2317
K_{80}	70.23	52.6	228.5	35.2	2720
K_{120}	73.52	52.5	257.6	36.4	3056
CD(P=0.05)	3.96	NS	18.6	1.10	334
NxP	NS	NS	NS	NS	NS

NS = Non-significant

weight dry chilli and yield with increase in levels of nitrogen and potassium. 300 kg N ha^{-1} along with 120 kg K_2O ha^{-1} was found superior in terms of yield in comparison to lower doses of fertilizer and control under irrigated dry conditions in transplanted chillies.

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Research Note

Variability in Drought Tolerant Rice

Key words: Drought Tolerance, Rice

Rice is a semi-aquatic species and a mild moisture stress even for a few days during the critical growth stage may decrease yield (Gomathinayagam *et al.*, 1992). In India, 58 per cent of the rice growing area is under rainfed condition (Michael Gomez *et al.*, 2003). Therefore, present investigation was conducted to estimate variability, heritability and genetic advance for eleven different characters in twenty four drought resistant genotypes and check of rice.

Twenty three drought resistant cultures PMK1, PMK 2, PMK 3, Norungan, Nootripattu, Varappu Kudainchan, Kuliyadichan, Thidal Kulichan, Chithiraikar, Sivappu Chithiraikar, Vellai Chithiraikar, Ariyan, Kuruvai Kalanjium, Aruvan Kuruva, Muttakurai, Poongar and IR 64 were raised in randomized block design and replicated thrice. Observations recorded for plant height, boot leaf area, number of panicles per plant, panicle length, root length, root weight, root volume, hundred grain weight, percentage of filled grains per panicle, harvest index and single plant yield on five random plants per genotype per replication.

The data were analysed as per Hanson *et al.*(1956) and Heritability (broad sense) and genetic advance as percentage over mean was worked out as per Lush (1949) and Johnson *et al.* (1955).

The genetic parameters namely GCV, PCV, ECV, heritability and GA as percentage over mean are given in Table. PCV was higher than GCV for all the characters and this suggests the influence of environment on different characters. But the difference between the PCV and GCV was lesser for characters like panicle length, hundred grain weight and single plant yield and it indicates less influence of environment on these characters. For characters like number of productive tillers per plant, root length, root weight and root volume difference between the PCV and GCV was higher. PCV was higher for charactgers like root weight, root length and number of productive tillers per plant. Higher PCV was obtained by Michael Gomez and Kalamani (2003) for number of grains per panicle. However, Allard (1960) suggested that phenotypic variability alone will not be sufficient and an estimate on genotypic variability is also very essential during a selection programme. Maximum PCV and GCV were observed for root weight and root volume. Similar results were also obtained by Michael Gomez and Rangasamy (2003) for the root weight alone.

Heritability estimates range from 4.74% (root length) to 84.77% (single plant yield). Percentage of heritability was higher for characters like single plant yield (84.77). hundred grain weight (84.56) and panicle length (77.01) and selection can be practiced based on phenotype for these character4s. But for a better selection breeding programme estimates on heritability alone will not be sufficient. Heritability coupled with genetic advance will be more rewarding in selection programme. High heritability coupled with high genetic advance as percentage of mean was noted for single plant yield indicating the preponderance of additive genes. High heritability coupled with moderate genetic advance as percent of mean was observed for hundred grain yield, plant height and boot leaf area.

In conclusion, selection of plant with high grain yield will improve the overall performance of drought tolerant rice cultures, as this character has high heritability coupled with high genetic advance. This can be followed by selection for hundred grain weight, plant height and boot leaf area.

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Table : Genetic parameters for different biometrical traits in drought tolerant rice cultures

Characters	GCV	PCV	ECV	Heritability	GA(%)of mean
Plant height	9.81	12.39	7.56	62.72	16.01
Boot leaf area	16.08	22.70	16.03	50.16	23.46
Number of grains	14.37	24.99	20.45	33.05	17.02
per panicle	7.67	8.74	4.19	77.01	13.87
Panicle length	3.56	16.37	15.98	04.74	1.59
Root length	27.95	51.93	43.76	28.97	30.99
Root weight	28.17	46.23	36.65	37.15	35.38
Root volume	11.04	12.00	4.71	84.56	20.91
Hundred grain	6.75	13.38	11.55	25.48	7.02
weight	10.54	18.54	15.24	32.37	12.36
Filled grains per	18.33	19.91	7.77	84.77	34.77
panicle (%)					
Harvest index					
Single plant yield					

GCV = Genotypic coefficient of varition
PCV = Phenotypic coefficient of variation
ECV = Environmental coefficient of variation
GA = Genetic advance

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Research Note
Genetic Variability and Character Association in Pigeonpea [*Cajanus cajan* (L.) Millsp]

Key words : Pigeonpea, Variability, Heritability, Genetic Advance, Correlation

Recently with the development of early maturing genotypes, pigeonpea is finding some place as sole crop in our cropping system. The material for the investigation comprised 70 diverse pigeonpea genotypes raised in randomized block design replicated twice, during *kharif* 2004 at Regional Agricultural Research Station, Lam. Each genotype was raised in two rows of 4m length adopting inter- and intra- row spacing of 150 and 20 cm respectively.

Genetic parameters of variability viz., phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance as per cent of mean (GA) were calculatd according to Johnson *et al.,* (1955). The phenotypic and genotypic correlation coefficients between seed yield and other yield component characters and among themselves were worked out as suggested by Croxten and Cowden (1964).

The differences among the genotypes were highly significant for all the traits studied. The mean, range, PCV, GCV, heritability, genetic advance and genetic advance as percentage of mean are presented in Table 1. Wide range of variability was observed in number of primary branches followed by pods per plant, pod yield per plant and seed yield per plant.

The estimates of GCV were lower than PCV. Highest magnitude of variability was recorded by number of pods per plant, followed by seed yield per plant as reported earlier by Magar (2003) and Basavarajaiah *et al.,* (2000).

In general the magnitude of heritability (broad sense) was higher for most of the characters studied. The etimates fo heritability (broad sense) were higher for the characters protein content, seed yield per plant, pods per plant, pod yield per plant, plant height, dry matter, primary branches, days to 50% flowering, harvest index, days to maturity, 100 seed weight, pod length and seeds per pod. In agreement with Magar (2003), and Deshmukh *et al.,* (2000).

High heritability (broad sense) coupled with high genetic advance as per cent of mean was observed for plant height, number of primary branches, number of pods per plant, pod yield per plant, seed yield per plant, 100-seed weight, dry matter per plant and harvest index, indicating operation of additive gene action in the inheritance of these traits and selection of these traits would be more effective

Table 1: Range and estimates fo genetic parameters for different characters of pigeonpea [Cajanus Canjan (L.) Millsp]

Character	Mean	Range		PCV (%)	GCV (%)	Heritability (%) (broad sense)	Genetic advance as per cent of mean
		Minimum	Maximum				
Days to 50% flowering	124.48	100.50	143.50	6.15	5.73	86.80	11.01
Days to maturity	172.48	135.50	192.00	4.68	4.11	77.20	7.45
Plant height (cm)	14.53	85.40	195.00	11.27	10.67	89.60	26.80
Primary branches	12.30	6.00	23.50	29.00	27.03	86.80	51.89
Pods per plant	15.17	55.70	562.60	53.46	51.50	92.80	72.20
Pod length(cm)	5.05	3.70	6.05	9.53	7.71	65.40	12.85
Seeds per pod	4.22	3.00	5.10	12.05	10.33	60.00	14.89
Pod yield per plant (g)	61.97	23.43	171.70	46.10	43.86	90.50	85.98
Seed yield per plant (g)	42.03	14.61	139.70	49.18	47.53	93.40	94.61
100 seed weight (g)	9.45	6.65	13.75	16.88	14.77	76.60	26.64
Dry matter per plant (g)	136.83	53.88	440.12	47.40	44.82	89.40	87.32
Shelling percentage	68.75	40.14	82.81	14.15	10.00	49.90	14.55
Harvest index	0.30	0.13	0.51	22.64	20.77	84.20	39.27
Protein content (%)	24.96	19.85	27.70	6.85	6.64	94.60	13.34

Table 2: Estimates of phenotypic (P) and genotypic (G) correlations in pigeonpea [*Cajanus cajan* (L.) Millsp].

		Days to maturity	Plant height	Primary branches	No.of pods/ plant	Pod length	Seeds/ pod	pod yield/ plant	100- seed weight	Dry matter / plant	Shelling (%)	Harvest index	Protein content	Seed yield/ plant
Days to 50% flowering	G	0.691**	0.068	-0.179*	-0.220**	0.272**	0.083	-0.216**	0.058	-0.203*	-0.155	-0.432**	-0.043	-0.272**
	P	0.821**	0.062	-0.213**	-0.242**	0.267**	0.047	-0.254**	0.057	-0.225**	-0.242**	-0.489**	-0.56	-0.303**
Days to maturity	G		-0.172*	-0.114	-0.113	0.283**	0.163	-0.038	0.007	-0.043	-0.164	-0.431**	0.030	-0.088
	P		0.182*	-0.131	-0.167*	0.487**	0.366**	-0.044	0.039	-0.076	-0.305**	-0.475**	0.034	-0.097
Plant height	G			0.359**	0.268**	-0.217**	-0.260**	0.264**	-0.244**	0.375**	0.219**	-0.321**	0.234*	0.287**
	P			0.369**	0.278**	-0.321**	-0.382	0.292**	-0.326**	0.415**	0.308**	-0.360**	0.250*	0.311**
Primary branches	G				0.707**	-0.345**	-0.326**	0.554**	0.001	0.532**	0.043	-0.135	-0.110	0.536**
	P				0.760**	-0.455**	-0.476**	0.617**	-0.021	0.610**	0.032	-0.143	-0.118	0.594**
No. of pods per plant	G					-0.480**	-0.431**	0.829**	0.130	0.806**	0.071	-0.043	-0.307**	0.784**
	P					-0.598**	-0.529**	0.848**	0.158	0.838**	0.092	-0.076	0.330**	0.829**
Pod length	G						0.787**	-0.319**	0.009	-0.405**	-0.126	-0.067	0.064	-0.385**
	P						0.685**	-0.455**	-0.057	-0.517**	-0.228**	-0.144	0.134	-0.485**
No. of seeds per pod	G							-0.315**	0.044	-0.375**	-0.037	0.025	0.086	-0.341**
	P							-0.423**	0.007	-0.476**	-0.223**	0.016	0.147	-0.446**
Pod yield per plant	G								0.132	0.919**	0.008	-0.028	-0.240**	0.919**
	P								0.145	0.961**	0.008	-0.086	-0.255**	0.967**
100 seed weight	G									0.033	0.058	0.049	-0.686**	0.066
	P									0.067	-0.031	0.011	-0.806**	0.040
Dry matter per plant	G										0.044	-0.107	-0.161	0.873**
	P										0.044	-0.139	-0.171*	0.936**
Shelling %	G											0.353**	-0.005	0.176*
	P											0.474**	0.020	0.200*
Harvest index	G												0.002	0.158
	P												-0.005	0.122
Protein content (%)	G													-0.154
	P													-0.163

*, ** Significant at 5% and 1% level of probability, respectively

for desird genetic improvement confirming the earlier reports by Deshmukh *et al.*, (2000), Basavarajaiah(2000) and Kingshlin and Subbraman (1999).

The magnitude of genotypic correlation was higher than phenotypic correlation (Table 2). Grain yield was found to be significantly and positively associated with pod yield dry matter, number of pods, primary branches, plant height and shelling percentage. Similar association of seed yield with these characters was reported by Magar (2003), Jagadish Singh (1999) and Khapre *et al.*, (1993). Primary branches showed significant positive association with number of pods per plant, pod yield per plant, seed yield per plant and dry matter per plant. Deshmukh *et al.*, (2000) reported significant positive correlation between number of primary branches per plant with seed yield. The number of pods per plant exhibitd a high significant positive association with seed yield per plant, pod yield per plant and dry matter per plant. It recorded negative association with pod length, seeds per pod and protein content as also reported by Deshmukh *et al.* (2000). Hundred seed weight showed significant negative association with protein content and plant height. Drymatter per plant exhibited significant positive association with seed yield per plant, pod yield per plant, pods per plant, primary branches and plant height while significant negative association with pod length, seeds per pod and days to 50% flowering. Jagadish Singh (1999) also reported that biological yield per plant exhibited positive association with plant hight and branches per plant. Protein content showed significant positive associ-ation with plant height while significant negative association with 100 seed weight, pods per plant and pod yield. Vineetshankar and Bajpai (1998) reported that protein content negatively significantly associated with 100 seed weight.

Thus, the present investigation revealed that the major emphasis should be laid on selection process for tall plant types with more number of pods per plant, number of branches per plant and dry matter for realising higher seed yield in pigeonpea.

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Research Note

Effect of Different Solid Media on Growth and Sporulation of *Colletotrichum gloeosporioides* (Penz.) Sacc

Key words : Oil palm, Anthracnose , Colletotrichum

Oil palm (*Elaeis guineensis Jacq.)* is the richest source of vegetable oil, which can yield 4-6 tons of palm oil and 0.4-0.6 tons of palm kernel oil per ha. per year, is a new introduction to our country. Now, it is grown in about 50,000 ha under rainfed and irrigated conditions. Recognizing the scope for commercial cultivation of this crop in India under irrigated conditions, potential areas were identified to the extent of 8 lakh ha in eleven states and the area under this crop is increasing steadily year by year at a slow pace. Oil palm is affected by a number of diseases and disorders not only at nursery stage but also at field level. Early leaf disease caused by *Colletotrichum gloeosporioides* (Teleomorph *Glomerella cingulata*) is the most important disease in nurseries. Very little information is available on the physiology of the fungus. Therefore, the present study was taken up on the nutritional factors required by the fungus.

Different solid media viz., potato dextrose agar (PDA), host leaf extract agar, Czapeck's agar, Richard's agar and glucose ammonium nitrate agar were prepared.

The ingredients for the media are as follows.

Potato dextrose agar (PDA)

Peeled potatoes	200 g
Dextrose	20.0 g
Agar	20.0g
Distilled water	1000 ml

Host leaf extract medium (HLE)

Host leaf bits	200 g
Agar	20.0 g
Distilled water	1000 ml

200 grams of leaf material was steamed for 2 hours in 1000 ml distilled water and then the extract was filtered and volume restored to 1000 ml with distilled water.

Czapeck's medium (CzM)

Sodium nitrate	2.0 g
Potassium dibasic phosphate	1.0 g
Potassium chloride	0.5 g
Magnesium sulphate	0.5 g
Ferrous sulphate	0.01 g
Sucrose	30.0 g
Agar	20g
Distilled water	1000 ml

Richard's medium (RM)

Potassium nitrate	10.0 g
Potassium dibasic phosphate	5.0 g
Magnesium sulphate	2.5 g
Ferric chloride	0.02 g
Sucrose	50.0 g
Agar	20.0 g
Distilled water	1000 ml

Glucose ammonium nitrate medium (GAN)

Glucose	50.0 g
Ammonium nitrate	2.40 g
Potassium monobasic phosphate	10.0 g
Magnesium sulphate	2.0 g
Agar	20.0 g
Distilled water	1000 ml

The media in petridishes were inoculated with *C.gloeosporioides* by transferring mycelial disk of 7 mm size with the help of a sterilized cork borer from seven days old culture. The linear growth of the fungus in agar media was estimated by measuring the diameter of the colony after full growth obtained in one treatment i.e. on 8th day. Three replicates were maintained for each medium. The data were analyzed statistically. Sporulation of the fungus in each treatment was rated visually.

Among the different media tested best growth was obtained on PDA and host leaf extract medium (90mm) followed by Czapeck's agar medium, Richards medium and GAN medium. In all the media the growth was luxuriant with white to light gray coloured mycelium except in glucose ammonium nitrate agar medium where the mycelium attained light red colour (Table).

The host leaf extract medium, RM and Czapeck's medium showed abundant sporulation while PDA favoured good sporulation and in glucose ammonium nitrate agar the sporulation was fair. The results are in agreement with the report of Singh and Kapoor (1971), Trinadh (1984) who worked on *C.gloeosporioides* on kagzi nimbu and acid lime and suggested PDA medium for

Table : Growth and sporulation of Colletotrichum gloeosporioides on differetn solid media.

Medium	Radial Growth* (mm)	Spore rating
Potato dextrose agar	90.0	+ ++
Richards medium	78.6	++++
GAN medium	64.3	++
Czapeck's medium	82.0	++++
Host leaf extract medium	90.0	++++
S.E	2.7	
C.D.	6.015	

*Mean of three replications

Sporulation: Abundant : ++++

Good : +++

Fair : ++

better mycelial growth. Gordillo queseda and Hernandez Lopez, (1980) reported tha the best mycelial growth and sporulation of *C. gloeosporioides* causing mango anthracnose were on mango dextrose agar. The higher spore ratings in Czapeck's agar and Richard's agar media was due to the carbon source i.e. sucrose used in above media. The oligosaccharides and polysaccharides induce better sporulation than hexoses (Bilgrami and Verma, 1986). Lilly and Barnett (1951) recommended the sucrose as carbon source for reproduction of *Glomerella cingulata*. However the abundant sporulation in HLE media may be due to the presence of all required nutrients in the natural media. Therefore, it is concluded that PDA and HLE medium favours maximum growth and HLE, RM and Czapeck's medium favours the abundant sporulation.

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Research Note

"SWOT" Analysis of Cotton Cultivation in Andhra Pradesh

Key words: SWOT, Cotton, Strengths, Weaknesses, Opportunities, Threats

The contribution of cotton to total exports is firmly established as on the top portion upto 1997, but export during 1997-98 and 1998-99 to other states is reduced considerably, the reason may be reduction in cotton cultivation. In India its production fell to 11.15 and 12.20 million bales respectively in the years of 1997-98 and 1998-99 from the highest 14.25 million bales recorded in the year of 1996-97. At this high time there is need for application of SOWT analysis for improvement in cotton.

Strength is the basic asset and advantage of cotton cultivation in Andhra Pradesh with respect to recommended technology that would provide competitive advantage for its growth and development. Weakness is the liability of cotton cultivation with respect to recommended technology that can be at a state of time and situation specific disadvantage for cotton farming. Opportunity is the ability of recommended cotton production technology to achieve specific objectives of cotton farming in Andhra Pradesh. Threat is a situation that may block the recommended cotton production technology to achieve objective.

Exploratory research design was followed. Two mandals in Guntur district of Andhra Pradesh were selected purposively for drawing the 110 sample for the study. From each mandal 3 villages were selected randomly. The data were collected by personal interview with the help of structured interview schedule.

The data obtained from the cotton farmers regarding SWOT parameters in cotton cultivation were quantified i.e., the number of farmers who gave the particular rank of Strengths, Weakness, Opportunities and Threats. The ranks attributed for different SWOT parameters and the frequency of farmers who gave ranks could be used for calculation of rank based quotient (RBO) (Sabarathnam, 1988). The important ten strengths, weaknesses, opportunities and threats ranked by respondents were discussed.

Strengths

The important ten strengths in cotton cultivation were identified based on rank and laced in the order which includes, growing of MCU5 for high market value (95.18), thinning and gap filling which increases the yield and maintenance of optimum plant population (89.81), removal of top leaves by toping in cotton plants (78.72), yield is 28 quintals / hectare (71), storing of kapas in gunnies or boras in well ventilated sheds (59.18), spraying of monocrotophos / tiazophos for control of white fly (49.54), trap cropping with castor / okra (40.63), ridges and furrows for easy application of irrigation water (28.54), frequent intercultivations to keep the crop weed free to conserve soil moisture (19.18), bright sunshine and hot climate (18.18).

Farmers gave first rank to MCU5 due to higher yields and good market value. The least rank was given to bright sunshine and hot climate. Similar findings were also recorded in Vyavasaya Panchangam (2000).

Weaknesses

The important ten weaknesses in cotton cultivation which were ranked in serial by cotton farmers were expensiveness of plant protection measures (94.09), low price to cotton at proper time (91.00), high cost of hybrid seed (84.09), costliness of fertilizer (65.18), non-availability of labour at proper time (62.63), insufficient supply of water (49.18), non-availability of fertilizers at proper time (39.72), lack of knowledge about disease diagnosis (32.00), non-availability of sufficient quantity of female labour for cotton picking (19.27) and lack of money at proper time (16.18).

The farmers expressed expensiveness of plant protection measures, which was an important weakness. They gave least rank to lack of money at proper time. The finding is in conformity with Anand Singh (1995), More *et al.* (1998), and not in conformity with Kulakarni *et al.* (1994)

Opportunities

From the result, it could be clear that growing MCU5 for high export potential (93.27), picking of kapas free from debris, dried leaves, bracts during cooler times of the day (89.09), conservation of natural enemies(81.72), use of yellow sticky trap for control of white fly (70.81), earthing up should be done with the help of a plough or blade harrow after fertilizer application and irrigation (56.63), application of helio NPV @ 500 Lt/ha of Bt formulation or neem seed kernel extract can be used for control of Helicoverpa and white fly (53.18), grading of kapas and shade dry for high market value (42.18), sowing the crop on ridges when sown under irrigation (27.63), during transport, kapas, should be protected from vagaries of weather, dust and dirt (19.45), use of pheromone traps for control of Helicoverpa (16.00) were the ten important opportunities as perceived by the respondents.

Farmers had given first rank to MCU5 for high export potential due to its good qualities, least rank to pheromone traps for control of Helicoverpa due to lack or knowledge in conformity with Venkat Rao (1999).

Threats

Ten important serious threats ranked by the respondents, were adulteration of seeds (91.45), cotton cannot tolerate excess moisture/water logging conditions (85.63), Alternaria / Cercospora / Helminthosporium leaf spots (81.81), moisture stress during flowering and boll formation to boll development stages, which reduces yield (77.72), boll opening and boll sheddings (57.18), environmental pollution (50.90), occurrence of rains at the time of weeding and harvesting operations (37.81), crust formation (31.72), harmful frosts (20.00) and collation of middlemen to fix the price of cotton (15.72).

Farmers gave first rank to adulteration of seeds and least rank to collation of middlemen to fix the price of cotton in conformity with More *et al.* (1998).

The results of the study showed that the major strengths, weakness, opportunities and threats in cotton cultivation which were ranked by cotton farmers were: Growing MCU5 for high market value, expensiveness of plant protection measures, growing MCU5 for high export potential and adulteration of seeds. SWOT analysis in cotton cultivation help the top administrators, planners of state government, scientists of cotton cultivation and cotton farmers to take strategic decision to overcome the weaknesses and threats in cotton cultivation.

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Research Note

Profile of the Jute Farmers of Nadia district of West Bengal

Key Words: Profile Characteristics, Jute Farmers

In India nearly four million small and marginal farm families are involved in jute farming. About 2.5 lakh workers are employed in jute industry and raw jute production as well as jute products. Socio-economic importance of jute cultivation lies in the fact that it ensures job for sizable section of rural population as it is a highly labour intensive crop. So, jute goods production stood at total of 15.93 lakh bales in 2003-2004. In case of raw jute production, India produces of 11.20 million bales (2003-2004), but could not cross the last year's production of 11.37 million bales (2002-03). The major pit falls of jute reproduction may be the lack of knowledge of recommended packages of practices and socio-economic characteristic of jute farmers.

The study was conducted in Nadia district of West Bengal purposively as it has the largest area under jute cultivation. Four blocks namely Karimpur, Nakashipara, Tehatta and Chapra were selected as per their area under jute cultivation and one village from each of these blocks was selected randomly with a total sample of 120 farmers by selecting 30 farmers each from each village. The data were collected through a structured interview schedule. The farmers were individually interviewed. The data were analyzed statistically.

The respondents according to the profile characteristics in the form of distribution table are given (Table 1) covering thirteen selected variables *viz.*, education, land holding, material possession, change proneness, extension contact, mass media exposure, socio-politico participation, risk orientation, scientific orientation, economic orientation, management orientation, value orientation and market orientation, *etc.*, indicating the response to the personal profile characteristics.

It could be observed form the Table that majority (26.66%) of the respondents belonged to primary schooling followed by illiterate (20.83%), middle school (17.50%), high school (14.16%) functionally illeterate (13.33%) and collegiate educational (7.52%) level as in the said order. The plausible reasons in this type of trend could be financial problem, non-availability of educational facilities and lack of awareness among elders in the village about education in conformity with Satyanarayana (2004).

Majority (46.66%) of the respondents were small farmers followed by semi medium (30.84%), medium (10.00%), large (7.50%) and marginal farmers (5.00%) in agreement with Satyanarayana (2004).

Majority (51.66%) of the farmers had low material possession and followed by medium (35.00%) and high (13.34%) levels of material possession, respectively in line with Venkata Kumar and Nanjaiyan (1999).

Most (49.17%) of the respondents had medium change proneness followed by high (25.83%) and low (25.00%) change proneness, respectively. In order to maintain moving equilibrium, it is obvious to look for a change and accept the new technology in concurrence with Sridevei (2003).

It is clear that majority (44.17%) of the jute farmers belonged to medium level of extension contact, followed by high (35.83%) and low (20.00%) level, respectively. The scientists, agricultural officers made frequent visits to villages for transfer of technology. This might be the reason for medium to high extension contact of the respondents as observed by Satyanarayana (2004). It was observed that 66.66% respondents were having high and medium level of mass media exposure and only one third were having low level of mass media exposure. It could be inferred that majority (39.17%) of the farmers were low level of socio-

Table : Profile characters at a glance of jute farmer of Nadia district of West Bengal. N=120

Independent variable	Category	Respondents	
		F	P
Education	Llliterate	25	20.83
	Functionally illiterate	16	13.33
	Primary school	32	26.66
	Middle school	21	17.50
	High school	17	14.16
	Collegiate school	9	7.52
Land holding	Marginal	6	5.00
	Small	56	46.66
	semi medium	37	30.84
	Medium	12	10.00
	Large	9	7.50
Material possession X̄: 2.483 ó : 0.888	Low(<1.595)	62	51.66
	Medium (1.596 to 3.371)	42	35.00
	High (>3.371)	16	13.34
Change proneness X̄: 16.825 ó : 1.872	Low (<14.95)	30	25.00
	Medium (14.96 to 18.69)	59	49.17
	High (>18.69)	31	25.83
Extension contact X̄: 23.91 ó : 2.082	Low (<21.00)	24	20.00
	Medium (21.01 to 25.17)	53	44.17
	High (>25.17)	43	35.83
Mass media exposure X̄: 5.224 ó : 1.246	Low (<3.97)	40	33.34
	Medium (3.98 to6.47)	34	28.33
	High (>6.47)	46	38.33
Socio-politico participation X̄: 2.025 ó : 1.736	Low (<0.28)	47	39.17
	Medium (0.29 to 3.76)	38	31.66
	High (>3.76)	35	29.17
Risk orientation X̄: 15.366 ó : 1.437	Low (<13.92)	32	26.67
	Medium (13.93to 16.80)	43	35.83
	High (>16.80)	45	37.50
Scientific orientation X̄:26.291 ó : 1.422	Low (<24.86)	11	9.16
	Medium (24.87 to 27.71)	51	42.50
	High (>27.71)	58	48.34
Economic orientation X̄:26.091 ó : 1.365	Low (<24.72)	14	11.67
	Medium (24.73 to 27.45)	52	43.33
	High (>27.45)	54	45.00
Managementorientation X̄:33.516 ó : 1.544	Low (<31.97)	28	23.34
	Medium (31.98 to 35.06)	25	20.83
	High (>27.45)	67	55.83
Value orientation X̄:16.674 ó : 1.196	Low (<15.45)	10	8.34
	Medium (15.48 to 17.87)	39	32.5
	High (>17.87)	71	59.16
Market orientation X:17.216 ó : 0.861	Low (<16.35)	22	18.34
	Medium (16.36 to 18.07)	44	36.66
	High (>18.07)	54	45.00

F= Frequency, P = Percentage

politico participation followed by almost equal percentage were medium (31.66%) and high (29.17%) socio-politico participation, respectively.

For low socio-politico participation, either the farmers did not consider necessary to have their own groups or did not seek membership in the organization that was already available. The factors for not being a member might be lack of interest and time, non-attractiveness of the activities undertaken by the organizations, lack of perceived benefits, lack of organization and local polities as was observed by Gayathri *et al.* (2004).

The farmers were having more risk preference, well aware of risk involved in adoption of new practice. A farmer, realized that calculated options had to be taken to increase the production and profits. Therefore, this was an indication of progressiveness. Farmers could not venture to take risk in adopting more recommended improved practices unless the practices were sufficiently demonstrated to show their performance. Similar observations were reported by Palaniswamy and Sriram (2001).

This trend in scientific orientation might be due to majority of respondents were small farmers with functional literacy having medium to high extension contact and mass media exposure, as also reported by Venkata Kumar and Nanjaiyan (1999).

The result of economic orientation might be due their desire to stabilize and improve economically with clear cut understanding of the advantages of the jute farming in concurrence with Palaniswamy and Sriram (2001).

About 75.00 per cent farmers belonged to medium and high level of management orientation. Since, the possession adds to the effectiveness of practicing innovation in their field, there was ample scope of using the resources judiciously to attain higher yields in terms of profits, thereby reflecting the effectiveness of farmers' capability to use innovation in their fields as was also observed by Shirur (2003).

More than 90.00 per cent of farmers belonged to medium and high level of value orientation might be due to jute farmers had belief in god and they gave value to certain norms and customs, in agreement with Shirur (2003).

The trend of market orientation might be due to majority of farmers had small holding with medium income, medium to high extension contact and mass media exposure and they wanted to gain more profits out of their produce. This trend also witnessed by Palaniswamy (2001) and shirur (2003). This warranted the better encouragement of market orientation on the part of the authorities, as this trait is one of the important factors in technology absorption among jute farmers.

Detailed analysis of profile characteristic of farmers indicated that the majority of the farmers were primary school educated, having semi medium land holding with low material possession. They were medium in change proneness and extension contact with high mass media exposure. They had low level of socio-politico participation but high risk orientation, scientific orientation, economic orientation, management orientation, value orientation and lastly market orientation.

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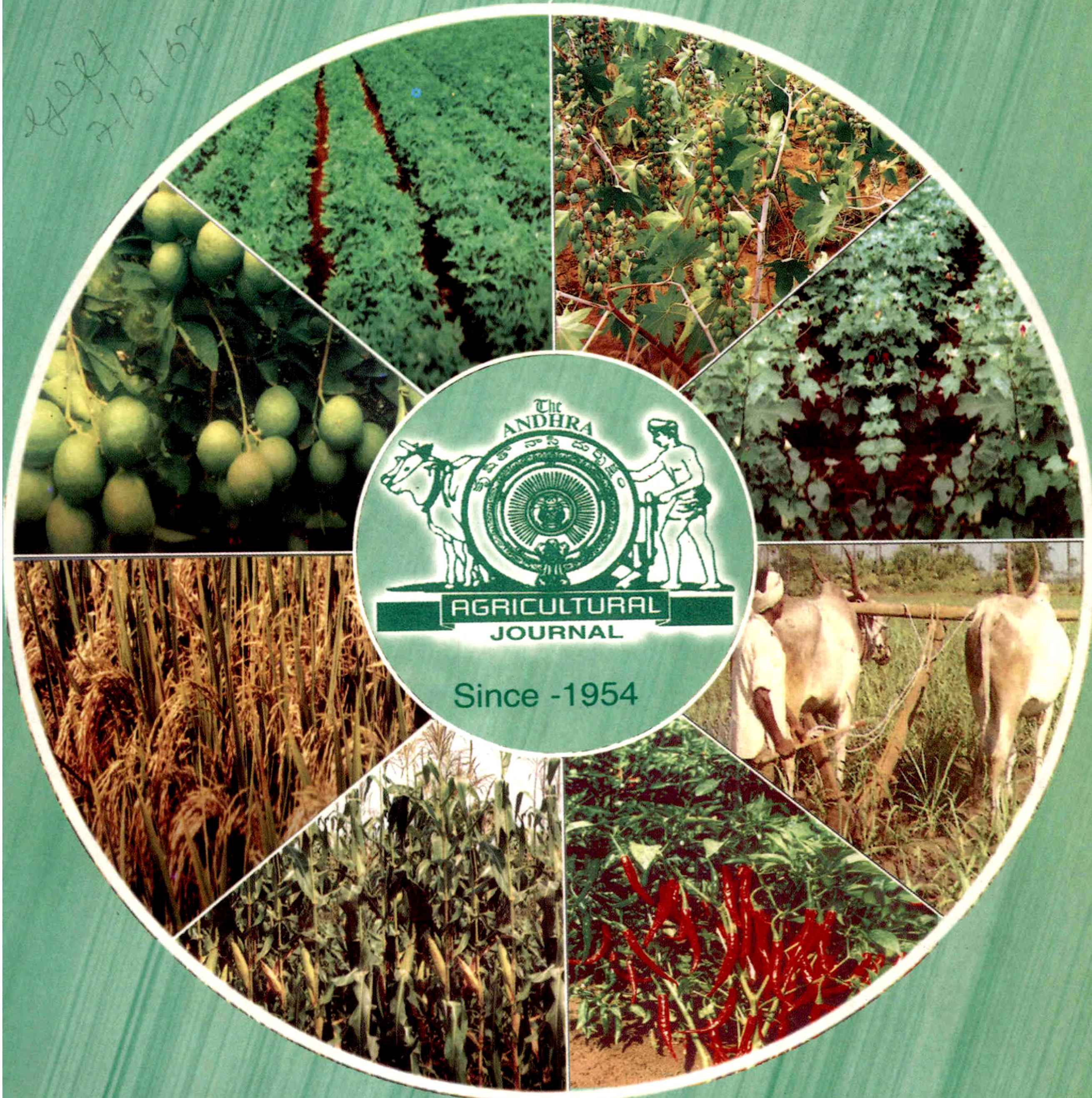

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Contents

Plant Sciences

Nutrient Uptake and Quality of Groundnut as Influenced by Moisture Conservation Practices and Fertilizer Management 126
B. Venkateswarlu

Assessment of Genetic Variability and Relationship of Yield Attributes in Introgressed Lines of American Cotton 129
J.S.V. Samba Murthy, N. Chamundeswari and P. Udayasree

Correlation and Path Analyses for Qualitative and Quantitative Traits in Inter-varietal Crosses of Chilli (*Capsicum annuum* L.) 133
B. Sivanageswara Rao, V. Chenga Reddy, Razia Sultana, V. Srinivasa Rao and J. Satish Babu

Multivariate Analysis in Rice (*Oryza sativa* L.) 136
D. Ramatulasi, K.V. Seetharamaiah, C. Panduranga Rao, V. Srinivasa Rao and B. Vijaya Laxmi

Application of Principal Component and Cluster Analyses in Chilli (*Capsicum annuum* L.) 141
B. Chatterjee, V. Chenga Reddy, J. Satish Babu, J.V. Ramana and C. Panduranga Rao

Multivariate Analysis in Soybean [*Glycine max* (L.) Merrill] 147
K. Sriranjani, M.V. Ramana, P.V. Rama Kumar and V. Srinivasa Rao

Combining Ability for Yield and Yield Component Traits in Cotton (*Gossypium hirsutum* L.) 152
K. Leela Pratap, V. Chenga Reddy, K.V.S. Reddy, C. Panduranga Rao

Character Association, Path Analysis and Selection Indices in Roselle (*Hibiscus sabdariffa* L.) 157
Ch. Rani, P.V. Rama Kumar, C. Panduranga Rao and V. Srinivasa Rao

Multivariate Analysis in Greengram [*Vigna radiata* (L.)Wilczek] 160
T. Supriya, S.S. Murthy, V. Srinivasa Rao and J.V. Ramana

Genetic Divergence in Frenchbean (*Phaseolus vulgaris* L.) 165
E. Ramaprasad, P.J.M. Rao, P.V. Rama Kumar and V. Srinivasa Rao

General Selection Indices in Finger Millet [*Eleusine coracana* (L.)Gaertn.] 172
G. Padmaja, C. Panduranga Rao, P.V. Rama Kumar and V. Srinivasa Rao

Selection Indices in Sesamum (*Sesamum indicum* L.) 174
P. Jyoshna Devi, P.V. Rama Kumar, V. Srinivasa Rao and J.V. Ramana

Evaluation of Sugarcane Genotypes Against Key Pests 176
Ch.V. Narasimha Rao, N. Venugopala Rao and B. Bhavani

Quantitative Changes in Biochemical Spectrum of *Epilachna vigintioctopunctata* (Fab.) (Coccinellidae : Coleoptera) *Helicoverpa armigera* (Hub.) and *Spodoptera litura* (Fab.) (Noctuidae : Lepidoptera) due to Calotropis gigantea *R. Br. Plant Parts Treatment* 178
S. Kanimozhi and R. Veeravel

Occurrence of Pest Complex on Cauliflower 181
P. Varalakshmi, P. Arjuna Rao, T. Madhumathi, P.V. Krishnaiah and V. Srinivasa Rao

Influence of Holding Solution, Dry Refrigeration and Packing Material on Quality and Longevity of Chrysanthemum Flowers 184
K. Surya Prakasa Rao and P.V. Rao

Effect of Seed Size on Seed Quality in Sunflower 187
G. Rama Rao and G. Mohan Naidu

Social Sciences

Historical Perspective and Theoretical Orientation of Micro-Watershed Management – A Review 190
M.V. Krishnaji and P. Venkataramaiah

Adoption of IPM Practices of Dry Paddy Growers of Maharashtra 193
D.P. Nagdev and P. Venkatramaiah

Strategic Models for Privatisation of Extension Services in Grape Enterprises 196
Mahantesh Sirur and P. Venkataramaiah

Sources of Information Utilized by the Women Farmers of Warangal District in Andhra Pradesh 200
G. Sivanarayana, T. Prasanta Kumar and P. Venkataramaih

Adoption Gaps of Technology – A Study on Rice in Krishna - Western Delta of Andhra Pradesh 203
B. Mukunda Rao, T.V. Satyanarayana, G. Suba Rao, D. Srinivas and K. N. Ravikumar

Economics of Production, Marketing and Storage of Maize in Karminagar District of Andhra Pradesh 206
M. Srikanth Reddy and N. Vasudev

Price spread of Walnut by Different Farm Size Groups in Budgam District of Jammu and Kashmir 211
Amod Sharma

Research Note

Estimation of Genetic Variability in F_2 Population of Sunflower (*Helianthus annuus* L.) 214
P. Lokanadhan and A. Gopalan

Genetic Variability in Sesame (*Sesamum indicum* L.) 216
S.V.S. Gangadhara Rao,

Nature of Gene Action for Quantitative Traits in Biparental Progenies of the Cross DCBI 799 X Gowri in Sesame 218
T. Anuradha and G. L. K. Reddy

Evaluation of Onion Cultivars for Late *Rabi* Season Under Krishna – Godavari Zone of Andhra Pradesh 220
N.Haripradasa Rao

Studies on Breaking Seed Dormancy of *Vicia sativa* 222
K Jayalalitha and R.S.N. Rao

Morphological Parameters and Total Biomass of Groundnut as Influenced by Teak Based Agro-forestry System 224
M.Venkata Rao, S.J.Patil and M.B.Chetti

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Journal
Since 1954

Nutrient Uptake and Quality of Groundnut as Influenced by Moisture Conservation Practices and Fertilizer Management

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ABSTRACT

In a field experiment conducted for two conservative rainy seasons at the Instructional Farm, College of Agriculture Junagadh, it was observed that pod and haulm yields, protein content, oil yield and protein yields were significantly higher in ridges and furrow, broad bed and furrow and deep ploughed seed bed methods of moisture conservation over flat bed. Applying 100% recommended dose of fertilizers and 50% RDF + 5 t FYM/ha were superior over control treatment with regard to yield and quality studies. Chemical analysis of plant and soil indicated that content of N, P, K and uptake of the same at harvest were significantly lower in flat beds over other methods tested where as the available N, P, K, Ca and Mg were equally influenced by various moisture conservation treatments. Fertilizer managements treatments significantly differed with one another with respect to pod and haulm yields, oil and protein yields. Applying 100% RDF registered the nutrient contents and uptake at highest values. Available nitrogen and phosphorus was the highest in the treatment receiving 100 RDF after harvest of the crop. The influence of fertilizer treatments were uniform in case of available Ca and Mg after the harvest of groundnut crop.

Key words : Fertilizer Management, Groundnut, In-situ Moisture Conservation

Suitable land configurations for in-situ moisture conservation and nutrient application either through fertilizers or organic sources or combination of these may enhance the groundnut yields. Very meager efforts have been made on developing an integrated approach in in-situ moisture conservation and combined application of inorganic and organic manures for groundnut crop under rainfed conditions. Hence, the present investigation was undertaken during two consecutive rainy seasons to study the influence of in-situ moisture conservation and fertilizer management treatments on yield, quality, nutrient uptake of groundnut and soil availability of nutrients after harvest of groundnut crop.

MATERIAL AND METHODS

The field experiment was conducted at the Instructional Farm, College of Agriculture, Junagadh, Gujarat on a clayey soil which was slightly alkaline in reaction. The soil was medium on available nitrogen (264 kg ha^{-1}), phosphorus (31.50 kg ha^{-1}) and potash (171 kg ha^{-1}). Four in-situ moisture conservation and three fertilizer management practices (Table 1) in main plot and sub plots respectively were tested in a split plot design replicated four times. Groundnut variety GG 20 was drilled in rows spaced at 60 cm by using 120 kg seed/ha. Groundnut crop was grown by following recommended package of practices as per treatments. Observations on yield, quality and nutrient uptake and nutrient availability were recorded as per standards procedures at harvest and the pooled data were used.

RESULTS AND DISCUSSION

Effect of in-situ moisture conservation

Data on pod and haulm yields (Table 1) indicated that ridges and furrow, broad bed and furrow and deep ploughed seed bed resulted in significantly higher pod and haulm yields over flat bed treatment which recoded the lowest pod and haulm yields (19.0 and 28.7 q/ha). Harvest index and oil content were uniformly influenced by different in-situ moisture conservation treatments. Protein content in kernels was also the lowest (21.02%) in flat bed treatment. Consequent of higher pod yields, the oil yield and protein yields were also higher in ridges and furrow, broad bed and furrow and deep ploughed seed beds over flat bed treatment. In altered land configurations, the soil moisture availability was higher due to in-situ moisture conservation over flat bed treatment. In flat bed treatment, soil moisture content was low which might had resulted in greater soil water tensions. This lower availability of soil water may increase the soil temperature compared to other treatments where soil moisture was relatively more.

Thus, the higher soil temperature along with available soil moisture may result in closure of slomata which tend to raise the plant body temperature and this would lead to greater respiration resulting in lower pod and haulm yields. Significantly higher uptake of nutrients (Table 2) in altered land configurations for in-situ moisture conservation could have also contributed towards

Table 1: Yield and quality of groundnut as influenced by moisture conservation and fertilizer management

Treatments	Pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Harvest index (%)	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
Land configuration							
Flat bed	19.0	28.7	39.84	49.23	670	21.02	286
Ridges and furrow	22.8	33.2	40.66	49.52	819	21.43	352
Broadbed and furrow	23.9	35.2	40.33	49.95	866	21.57	373
Deep ploughed seed bed	23.8	35.2	40.28	0.16	864	21.46	370
SEm+	0.7	1.1	1.09	0.87	30.91	0.11	10.82
CD (P=0.05)	2.2	3.3	NS	NS	91.85	0.32	32.15
Fertilizer Management							
Control	19.5	30.4	29.23	49.29	687	20.96	292
50% RDF + 5t FYM ha-1	22.5	33.3	40.11	49.80	819	21.41	347
100% RDF	25.2	35.6	41.48	50.05	919	21.75	398
SEm+	0.6	0.8	0.74	6.35	21.77	0.07	9.20
CD (P=0.05)	1.7	2.3	NS	NS	61.95	0.19	26.16

RDF = Recommended dose of fertilizers i.e., 12.5 kg N and 25 kg P_2O_5 ha^{-1}
NS = Non-significant.

higher pod and haulm yields. Similar results were reported by Ingole ***et. al.*** (1998) and Basu (1999).

Data in Table 2 suggest that nitrogen, phosphorus and potassium content in plant and uptake was significantly higher in ridges and furrow, broad bed and furrow and deep ploughed seed bed over flat bed treatment. Residual available nitrogen, phosphorus, potassium, calcium and magnesium were uniformly influenced by the in-situ moisture conservation methods. The lowest nutrient content and uptake were registered in flat bed treatment. In ridges and furrow, broad bed and furrow and deep ploughed seed bet treatments, the soil in good physical condition favoured the in-situ moisture conservation and resulted in better and higher soil moisture conditions. This increased soil moisture which favoured the root proliferation and also the availability of plant nutrients. The readily and continuously available soil moisture could also help in increased availability of nutrients and also the diffusion process resulting in higher nutrient absorption and there by the nutrient content in plant. The higher nutrient contents coupled with high pod and haulm yields might have resulted in higher nutrient uptake as also reported by Desai (1989).

Table 2: Nutrient content (%), Nutrient uptake (kg ha^{-1}) of groundnut and available soil nutrients (kg ha^{-1}) as affected by moisture conservation and fertilizer management at harvest.

Treatments	N con tent	N up take	P con tent	P uptake	K con tent	K up take	N	P	K	Ca	Mn
Land configuration											
Flat bed	2.336	111.59	0.256	12.24	1.072	51.22	156	23.32	140.3	39.29	8.62
Ridges and furrow	2.459	137.57	0.286	16.05	1.237	69.54	152	22.87	140.9	38.19	7.78
Broadbed and furrow	2.444	144.76	0.286	16.99	1.249	72.22	154	23.16	140.7	38.75	7.89
Deep ploughed seed bed	2.442	144.43	0.88	17.03	1.247	73.97	154	23.18	140.0	38.84	7.91
SEm+	0.015	2.66	0.003	0.42	0.007	1.48	1.97	0.30	1.64	0.47	0.10
CD (P=0.05)	0.045	7.89	0.008	1.24	0.020	4.41	NS	NS	NS	NS	NS
Fertilizer Management											
Control	2.363	116.29	0.269	13.36	1.115	55.42	150	22.49	131.5	38.84	7.92
50% RDF + 5t FYM ha-1	2.436	136.4	0.279	15.67	1.205	67.72	165	24.53	144.6	38.92	7.93
100% RDF	2.483	151.01	0.290	17.70	1.284	78.57	148	22.37	145.1	38.54	7.85
SEm+	0.010	2.83	0.002	0.33	0.003	1.39	1.28	0.20	1.17	0.34	0.06
CD (P=0.05)	0.029	11.90	0.005	0.95	0.069	3.97	3.5	0.5	3.33	NS	NS

RDF = Recommended dose of fertilizers i.e., 12.5 kg N and 25 kg P_2O_5 ha^{-1}
NS = Non-significant.

Effect of fertilizer management

Pod and haulm yields were significantly influenced by different fertilizer treatments. All the treatments differed significantly with one another 100% RDF registered the highest pod (25.2 q/ha) and haulm (35.6 q/ha) yields. Harvest index was uninfluenced by fertilization treatments. Higher availability and uptake of nutrients (Table 2) could be the reason for higher yields. Kachot (1999) also reported similar results.

Quality characters in Table 1 revealed that treatments effect on oil content was non-significant while the oil yield, protein content and protein yield were significantly higher in the treatment receiving 100% recommended fertilization while the lowest values were recorded in the control treatment. Oil biosynthesis is a complex process governed by the genetic makeup. Hence, it is always difficult to modulate this content through management practices. As nitrogen is an integral part of protein and phosphorus is the structural element of certain co-enzymes involved in protein synthesis high protein content was observed in the fertilized plots. The increase in yield of oil and protein might be due to the cumulative effect of pod yield as also reported by Lourdraj *et. al.* (1998).

Nitrogen, phosphorus and potassium content in plant and their uptake by groundnut was higher in the treatment receiving 100% RDF followed by the treatment receiving 50% RDF + 5 t FYM/ha. Control treatment registered the lowest values. The application of nitrogen and phosphorus through fertilizers and FYM increased the availability of plant nutrients upon decomposition and release of organic acids and absorption of nitrogen, phosphorus and potassium resulting in higher contents of the same in the plant.

Residual available nitrogen, phosphorus, potassium were significantly influenced by the fertilization treatments where as the available calcium and magnesium were not influenced. The highest available nitrogen (165 kg/ha) and phosphorus (24.53 kg/ha) were registered in the treatment receiving 50% RDF + 5 t FYM. High available potassium 145.7 kg/ha was recorded in the treatment receiving 1005 RDF which was comparable with 144.3 kg/ha in the treatment receiving 505 RDF + 5 t FYM/ha. The lowest available nutrients were observed in the control treatment. The organic matter applied through FYM could show higher residual nutrient availability. This might be due to addition of these nutrients through the applied FYM due to slow release. Organic manures upon decomposition liberate carbon dioxide and organic acids which increase the availability of nutrients from native as well as applied fertilizers in conformity with Kachot (1999).

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Journal
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Assessment of Genetic Variability and Relationship of Yield Attributes in Introgressed Lines of American Cotton

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ABSTRACT

Sixty-two introgressed lines of *Gossypium hirsutum* L. along with two checks were evaluated for genetic variability for agronomic and quality characters for two seasons. Significant genotypic differences exist among the genotypes for all the characters. Seed cotton yield per plant, number of bolls per plant and fibre quality index showed moderate to high genotypic coefficient of variation, heritability values and high genetic gain. Correlations between seed cotton yield and each of eleven characters were partitioned into direct and indirect effects. Number of bolls per plant, boll weight and 2.5% span length were the most important characters in exerting maximum direct effect on seed cotton yield and should be given due weightage in yield improvement programmes.

Key words : Genetic Variability, American Cotton

Cotton is an important commercial crop of Andhra Pradesh playing a significant role in the socio-economic status of the farmers. In any crop improvement programme, breeder has to select superior genotypes based on their phenotypic performance. However, phenotypic selection sometimes misleads the breeder since the variability expressed in the traits arises from joint action of heritable and non-heritable components. Hence, the present investigation is aimed at estimating genetic parameters, correlations and path coefficients in *Gossypium hirsutum* cotton for twelve characters.

MATERIAL AND METHODS

Sixty two introgressed lines of *Gossypium hirsutum* along with two checks were evaluated at Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh during two consecutive seasons *i.e, kahrif* 2001-02 and *kharif* 2002-03 under Cotton Technology Mission Project. These lines were developed across the Cotton Research Centres of the country out of introgression with different species of *Gossypium* for various biotic and abiotic stress tolerance besides fibre quality improvement. These lines were sown in randomized block design with two replications. Each entry was sown in two rows of 6 m length with inter- and intra- row spacing of 120 x 60 cm. Five plants at random were selected from each entry in each replication and observations on boll weight, number of bolls per plant, seed index, lint index, ginning out turn, 2.5% span length, uniformity ratio, micronaire, bundle strength, fibre quality index and seed cotton yield were recorded. The fibre quality index (FQI) was calculated as :

$$\text{FQI} = \frac{\text{Fibre strength at 3.2 mm guage x Fibre length (2.5\%)}}{\sqrt{\text{Micronaire value (Fibre fineness)}}}$$

The data were subjected to statistical analysis as per singh and Choudhary (1977).

RESULTS AND DISCUSSION

Pooled analysis of variance revealed sufficient variability in the material studied. Estimates of genetic parameters of different characters are presented in Table 1. It is evident that the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the characters suggesting different levels of interactions with the environment. High genotypic coefficient of variation was recorded for seed cotton yield per plant (33.60%) followed by number of bolls per plant (28.15%) which is in conformity with Tuteja *et. al.* (2004). Moderate genotypic coefficient of variation was observed for fibre quality index (16.75%) followed by lint index (14.68%), boll weight (12.52%), seed index (9.77%), 2.5% span length (10.48%) and bundle strength (9.90).

High heritability estimates coupled with high genetic advance were observed for bundle strength, fibre quality index, 2.5% span length and seed cotton yield per plant (Rao and Reddy, 2001 and Neelam and Potdukhe, 2002). This may be attributed to additive gene action (Panse, 1957). It therefore appears that pure line selection for these characters will be rewarding. Moderate heritability values with moderate genetic gain was observed in case of boll weight, seed index, lint index and micronaire revealing the role of both

Table 1 : Estimates of variability, heritability and genetic advance for yield and its component characters in cotton (Gossypium hirsutum L.)

Character	Range		Mean	GCV (%)	PCV (%)	Heritability (Broad sense)	GA as % of mean
	Minimum	Maximum					
Boll weight (g)	2.39	4.82	3.50	12.55	16.85	55.5	19.25
No. of bolls/plant	13.30	70.10	35.51	28.15	36.95	58.0	44.18
Seed index (g)	6.30	10.75	8.46	9.77	14.66	44.4	13.41
Lint index (g)	2.80	5.25	3.89	14.68	19.03	59.6	23.33
ginning out turn (%)	28.65	36.35	32.61	3.65	5.76	40.2	4.77
2.5% span length (mm)	20.90	31.31	24.78	10.48	12.08	75.2	18.71
Uniformity ratio	43.50	54.50	49.73	4.65	7.28	40.8	6.11
Micronaire (10^{-6} g/inch)	2.57	4.25	3.38	8.93	13.40	44.4	12.25
Maturity coefficient	0.57	0.67	0.61	3.29	5.17	40.7	4.33
Bundle strength (g/tex)	16.80	28.07	21.89	9.90	10.60	87.3	19.07
Fibre quality index	194.28	442.78	298.75	16.75	18.80	79.4	30.74
seed cotton yield/plant (g)	46.70	177.85	112.29	33.60	40.45	69.2	57.69

GCV = Genotypic coefficient of variation, PCV = Phenotypic , coefficient of variation
GA = Genetic advance

additive and non-additive gene effects on these traits. These results are in conformity with Dhanda *et. al.* (1987) for boll weight and micronaire and Singh *et. al.* (1987) for seed index and lint index. These traits are controlled by non-additive gene action.

The phenotypic correlation coefficients between yield and yield components are presented in Table 2. It is interesting to note that all the yield attributing characters showed significant positive correlation with seed cotton yield. They are number of bolls per plant (0.7236), seed index (0.2211), lint index (0.1717), 2.5% span length (0.1540), boll weight (0.1532) and micronaire (0.1397). These results are in broad agreement with Rajarathinam *et. al.* (1993), Neelam and Potdukhe (2002) and Altaher and Singh (2003). However uniformity ratio had significant negative correlation with seed cotton yield which is confirmed by earlier workers (Rajarathinam *et. al.* 1993).

The other significant positive correlations between character pairs observed are boll weight with number of bolls per plant, seed index, lint index, ginning out turn, 2.5% span length, micronaire and fibre quality index; seed index with

Table 2: Phenotypic correlation coefficients for seed cotton yield and its component characters in cotton (Gossypium hirsutum L).

Character	No. of bolls per plant	Seed index (g)	Lint index (g)	Ginning out turn %	2.5% span length (mm)	Uniformity ratio	Micronaire (10^6 g/ inch)	Maturity coefficient	Bundle strength (g/tex)	Fibre quality index	Seed cotton yield (g)
Boll weight (g)	-0.4128**	0.5407**	0.5954**	0.2823**	0.4499**	-0.0579	-0.0436	0.2004	0.1009	0.3486**	0.1532*
No. of bolls/plant		-0.1473*	-0.2209**	-0.1602**	-0.1092	-0.1455	0.0402	-0.0391	-0.1781**	-0.1952**	0.7236**
Seed index (g)			0.7405**	0.0349	0.3624**	-0.0929	-0.1130	0.1118	0.1293*	0.3254**	0.2211**
Lint index (g)				0.4546**	0.5174**	-0.1782**	-0.0457	0.1544*	0.2063**	0.4485**	0.1717**
Ginning out turn (%)					0.3300**	-0.0994	0.0535	0.1227*	0.1456*	0.2815**	0.0126
2.5% span length (mm)						-0.1218*	-0.0047	0.1461*	0.1618**	0.7406**	0.1540*
Uniformity ratio							0.0113	-0.0440	0.0043	-0.0816	-0.1632**
Macronaire (10^{-6} g/inch)								-0.0391	-0.1150	-0.3979**	0.1397*
Maturity coefficient									0.2139**	0.2066**	0.0414
Bundle strength (g/tex)										0.6784**	-0.0707
Fibre quality index											-0.0134

*, ** Significant at 5% and 1%, respectively.

lint index, 2.5% span length, fibre quality index and bundle strength; lint index with ginning out turn, 2.5 span length, bundle strength, fibre quality index and micronaire; ginning out turn with 2.5% span length, bundle strength and micronaire; 2.5% span length with fibre quality index, bundle strength and micronaire with bundle strength and fibre quality index, bundle strength with fibre quality index. Whereas negative and significant associations were observed between boll weight and number of bolls per plant; number of bolls

Table 3: Direct (bold) and indirect effects of yield components on yield in cotton (Gossypium hirsutum L.).

Character	Boll weight (g)	No. of bolls per plant	Seed index (g)	Lint index (g)	Ginning out turn (%)	2.5% span length (mm)	Uniformity ratio	Micro-naire (10^{-6} g/inch)	Maturity coeffi-cient	Bundle strength (g/tex)	Fibre quality index	Correlation with seed cotton yield
Boll weight (g)	**0.4921**	0.3893	0.0346	0.0263	-0.0003	0.0941	-0.0006	-0.0011	-0.0089	0.0240	-0.1176	0.1532**
No. of bolls / plant	-0.2031	**0.9433**	-0.0088	-0.0097	0.0002	-0.0228	-0.0016	0.0010	0.0017	-0.0423	0.0659	0.7236**
Seed index (g)	0.2661	-0.1295	**0.0639**	0.0327	0.0000	0.0758	-0.0010	-0.0028	-0.0050	0.0307	-0.1098	0.2211**
Lint index (g)	0.2930	-0.2083	0.0474	**0.0441**	-0.0004	0.1083	-0.0019	-0.0011	-0.0069	0.0490	-0.1513	0.1717**
Ginning out turn (%)	0.1389	-0.1511	0.0022	0.0200	**-0.0010**	0.0691	-0.0011	0.0013	-0.0055	0.0346	-0.0950	0.0126
2.5% span length (mm)	0.2214	-0.1030	0.0232	0.0228	-0.0003	**0.2092**	-0.0013	-0.0001	-0.0065	0.0384	-0.2498	0.1540
Uniformity ratio	-0.0285	-0.1372	-0.0059	-0.0079	0.0001	-0.0255	**0.0109**	0.003	0.0020	0.0010	0.0275	-0.1632**
Micronaire (10^{-6} g/inch)	-0.0215	0.0379	-0.0072	-0.0020	-0.0001	-0.0010	0.0001	**0.0247**	0.0017	-0.0273	0.1342	0.1397*
Maturity Coefficient	0.0986	-0.0369	0.0071	0.0068	-0.0001	0.0306	-0.0005	-0.0010	**-0.0444**	0.0508	-0.0697	0.0414
Bundle strength (g/tex)	0.0497	-0.1680	0.0083	0.0091	-0.0001	0.0338	0.0000	-0.0028	-0.0095	**0.2377**	-0.2289	-0.0707
Fibre quality index	0.1716	-0.1842	0.0208	0.0198	-0.0003	0.1549	-0.0009	-0.0098	-0.0092	0.1612	**-0.3374**	-0.0134

Residual effect = 0.4478

per plant with seed index, lint index, ginning out turn, uniformity ratio, bundle strength and fibre quality index; 2.5% span length with uniformity ratio, micronaire and fibre quality index.

The direct and indirect effects of component characters on yield are presented in Table 3. The character number of bolls per plant exhibited maximum positive direct effect (0.9433) as against its highest positive significant correlation value with seed cotton yield per plant (0.7236) in conformity with Ladole and Meshram (2000) and Altaher and Singh (2003). Highest negative direct effect of bolls per plant was reported by Koushik *et. al.* (2003). The other characters with positive direct effect were boll weight (0.4921), bundle strength (0.2377) and 2.5% span length (0.2092). This is confirmed by Dhanda *et. al.* (1984), Kowsalya and Raveendran (1996) and Ladole and Meshram (2000) for one or more characters. The residual effect was higher (0.4478) in magnitude indicating that these characters could not sufficiently explain the variability in seed cotton yield. It indicates that there might be a few more characters other than those studied which might influence the yield. Results of path coefficient analysis clearly indicated that due weightage should be placed on number of bolls per plant, 2.5% span length and boll weight as they contributed directly towards high seed cotton yield.

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Correlation and Path Analyses for Qualitative and Quantitative Traits in Inter-varietal Crosses of Chilli (*Capsicum annuum* L.)

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ABSTRACT

The correlation studies with 42 inter-varietal crosses along with their 13 parents of chilli revealed the importance of plant height, number of branches per plant, plant spread, number of fruits per plant, fruit length, fruit weight, 1000-seed weight, capsaicin, capsanthin and oleoresins in determining the fruit yield per plant. The path coefficient analysis brought out the plant height, primary and secondary branches per plant, plant spread, number of fruits per plant, fruit weight and oleoresins as major yield components, which could be considered for improvement.

Key words : Correlation, Path Analysis, Chillies

The gain from selection in crop breeding programme is dependent on the amount of variability for economic characters. The selection process is complicated by complex nature of yield by interplaying with its component characters. A better understanding of the contribution of such traits in building up the genetic make up of the crop may be obtained through correlation and path analyses.

MATERIAL AND METHODS

The F_1 progenies of 42 crosses obtained by crossing 7 females and 6 males in line x tester design along with 13 parents were used for the estimation of the character association and path analyses of the characters days to 50% flowering, plant height, number of primary branches per plant, number of secondary branches per plant, plant spread, days to fruit ripening, number of fruits per plant, fruit length, fruit girth, fruit weight, number of seeds per fruit, 100 pod weight, 1000 seed weight, fresh fruit yield per plant, dry pod yield per plant, capsaicin, oleoresins and capsanthin. The analysis of character association was worked out as suggested by Falconer (1964) and the direct and indirect contribution of component characters to yield was calculated through path coefficient analysis as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The correlation between dry pod yield per plant along with different yield attributes and amongst the attributes themselves are presented in the Table 1. The characters days to 50% flowering and days to fruit ripening exhibited significant negative correlation with dry pod yield indicating that earliness improves the yield of a plant in conformity with Khurana *et. al.* (2003) and Mallikarjun *et. al.* (2003).

The correlation between fruit yield and its determining characters revealed that plant height (Khurana *et. al.*, 2003), number of primary and secondary branches per plant (Hari *et. al.*, 2005), plant spread, number of fruits per plant (Mallikarjun *et. al.*, 2003), fruit length, fruit weight and number of seeds per fruit (Choudhary and Samadia, 2004), 1000 seed weight (Gogoi and Gautam, 2003), capsaicin (Khurana *et. al.*, 2003), capsanthin and oleoresins (Mallikarjun *et. al.*, 2003) had significant positive correlation with dry pod yield per plant indicating that selection for the improvement of these plant traits also leads to the simultaneous improvement of dry pod yield. The production of increased vegetative growth like plant height and plant spread might have led to larger canopy of the plant and give rise to more root development along with increased number of primary and secondary branches per plant resulting in photosynthetic efficiency and more number of fruits and finally yield.

Significant and positive inter-se correlations were also recorded among these characters, which indicates that fruit yield per plant was a totality of these characters. Simultaneous selection must be adopted to achieve substantial improvement in yield. Character association between characters show phenomenon of correlated response and the genetic factors responsible for this linkage and pleiotropy.

Path coefficient analysis was worked out to get an insight into the direct and indirect effects of different characters on yield and the results are presented in the Table 2. The correlation

Table 1: Genotypic and phenotypic correlation coefficients between yield and yield components in chilli (Capsicum annuum L.)

Character	Days to 50% flower-ing	Plant height	No. of primary branches per plant	No. of secondary branches per plant	Plant spread	Days to fruit ripening	No. of fruits per plant	Fruit length	Fruit girth	fruit weight	100 pod weight	1000 seed weight	No. of seeds per fruit	Fresh fruit yield / plant	Capsa-icin (%)	Oleo-resins (%)	Capsa-nthin (EOA values)	Dry pod yield per plant
Days to 50% flowering		-0.237**	0.273**	-0.497**	-0.564**	0.554**	-0.273**	-0.421**	-0.461**	-0.366**	-0.231**	0.162*	-0.462**	-0.277**	-0.145	-0.251**	-0.281**	-0.313**
Plant height	-2.212**		0.044	0.486**	0.658**	-0.118	0.547**	0.246**	0.140	-0.043	0.058	0.213**	0.279**	0.404**	-0.272**	0.420**	0.249**	0.477**
Primary branches	0.251**	0.043		0.286**	0.130	0.063**	0.264**	-0.118	-0.254**	0.010	-0.163*	0.216**	0.027	0.389**	0.125	0.226**	0.303	0.476**
Secondary branches	-0.447**	0.450**	0.258**		0.684**	-0.449**	0.545**	0.477**	0.298**	0.354**	0.324**	0.092	0.536**	0.688**	0.147	0.315**	0.460**	0.761**
Plant spread	-0.540**	0.637**	0.126	0.645**		-0.485**	0.666**	0.470**	0.326**	0.286**	0.296**	0.105	0.559**	0.625**	0.310**	0.446**	0.368**	0.726**
Days to fruit ripening	0.506**	0.923**	0.051	-0.412**	-0.446**		-0.237**	-0.249**	-0.056	-0.309**	-0.336**	0.108	-0.335**	-0.405**	-0.056	-0.169*	-0.433**	-0.433**
No. of fruits per plant	-0.263**	0.518**	0.256**	0.504**	0.655**	-0.218**		0.262**	-0.022	-0.033	-0.109	0.149	0.343**	0.612**	0.598**	0.595**	0.080	0.691**
Fruit length	-0.396**	0.221**	-0.112	0.440**	0.454**	-0.231**	0.252**		0.416**	0.388**	0.587**	0.063	0.441**	0.459**	-0.079	0.057	0.435**	0.433**
Fruit girth	-0.413**	0.125	-0.242**	0.273**	0.310**	-0.055	-0.017	0.405**		0.505**	0.560**	0.228**	0.566**	0.184**	-0.207*	-0.128	0.285**	0.124
Fruit weight	-0.327**	-0.033	0.014	0.295**	0.252**	-0.286**	-0.022	0.323**	0.441**		0.760**	0.060	0.668**	0.352**	-0.218*	-0.193*	0.367**	0.365**
100 pod weight	-0.213**	0.052	-0.162*	0.314**	0.290**	-0.300**	-0.108	0.566**	0.533**	0.650**		0.143	0.638**	0.321**	-0.278**	-0.253**	0.368**	0.290**
1000 seed weight	0.142	0.199*	0.206**	0.063	0.098	0.102	0.141	0.052	0.197*	0.043	0.119		0.041	0.424**	0.109	0.158*	0.017	0.315**
No. of seeds per fruit	-0.441**	0.277**	0.026	0.510**	0.545**	-0.299**	0.331**	0.426**	0.532**	0.566**	0.611**	0.035		0.423**	0.144	0.245**	0.241**	0.457**
Fresh yield / plant	-0.257**	0.374**	0.374**	0.631**	0.603**	0.360**	0.591**	0.442**	0.176*	0.293**	0.314**	0.379**	0.398**		0.352**	0.327**	0.395**	0.936**
Capsaicin	-0.137	0.262**	0.122	0.140	0.307**	-0.051	0.592**	-0.080	-0.200*	-0.192*	-0.271**	0.102	0.143	0.343**		0.611**	-0.258**	0.341**
Oleoresins (%)	-0.241**	0.406**	0.222**	0.299**	0.442**	-0.151	0.588**	0.057	-0.123	-0.168*	-0.248**	0.149	0.242**	0.340**	0.609**		-0.163*	0.422**
Capsanthin (EOA values)	-0.271**	0.241**	0.030	0.437**	0.365**	-0.399**	0.080	0.425**	0.276**	0.323**	0.360**	0.016	0.237**	0.385**	-0.257**	-0.162*		0.356**
Dry pod yield / plant	-0.278**	0.432**	0.447**	0.677**	0.692**	-0.393**	0.661**	0.408**	0.121	0.311**	0.273**	0.268**	0.415**	0.909**	0.324**	0.404**	0.340**	

Above diagonal values are genotypic, below are phenotypic. * Significant at 5% level ** Significant at 1% level.

coefficients of primary and secondary branches per plant, plant spread, number of fruits per plant, fruit weight and oleoresins on dry pod yield per plant were observed to be due to the direct effects of these traits on yield. Therefore, direct selection on these traits could be very effective to develop high yielding genotypes. Further, the indirect effects of these traits strengthened the association exhibited by them with yield. Findings of earlier workers also showed positive direct effect for primary branches per plant (Gogoi and Gautam, 2003) and number of fruits per plant (Choudary and Samadia, 2004).

Days to 50% flowering and days to fruit ripening has negative direct effects on yield indicating that early flowering and maturity are highly desirable in agreement with Choudhary and Samadia (2004). The direct effects are negative for fruit length, fruit girth (Choudhary and Samdia, 2004), 1000 seed weight (Venkata Reddy, 1997), number of seeds per fruit (Choudhary and Samdia, 2004), capsaicin and capsanthin (Venkata Reddy, 1997). In this situation selection should be practiced for the traits which show positive indirect effects to reduce the undesirable direct effects.

The residual effect of 0.2 revealed that 80 per cent of yield was contributed by the characters studied and thus indicated the adequacy of the characters. Low residual effect also signifies the appropriateness of chosen characters in representing the total variability and all the important characters taken for study are correlated with dry pod yield per plant.

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Table 2: Estimates of direct and indirect effects (phenotypic) between yield and yield componetns n chilli (Capsicum annuum L.)

Character	Days to 50% flowering	Plant height	No. of primary branches per plant	No. of secondary branches per plant	Plant spread	Days to fruit ripening	No. of fruits per plant	Fruit length	Fruit girth	fruit weight	100 pod weight	1000 seed weight	No. of seeds per fruit	Fresh fruit yield / plant	Capsaicin (%)	Oleoresins (%)	Capsanthin (EOA values)
Days to 50% flowering	0.025	-0.005	0.006	-0.011	-0.014	0.013	-0.007	-0.010	-0.010	-0.008	-0.005	0.004	-0.011	-0.006	-0.003	-0.006	-0.007
Plant height	-0.005	0.026	0.001	0.012	0.016	-0.002	0.013	0.006	0.003	-0.001	0.001	0.005	0.007	0.010	0.007	0.011	0.006
Primary branches	0.032	0.006	0.129	0.033	0.016	0.007	0.033	-0.014	-0.031	0.002	-0.021	0.027	0.003	0.049	0.016	0.029	0.004
Secondary branches	-0.027	0.027	0.016	0.060	0.039	-0.025	0.030	0.026	0.016	0.018	0.019	0.004	0.031	0.038	0.008	0.018	0.026
Plant spread	-0.091	0.107	0.021	0.109	0.169	-0.075	0.110	0.077	0.052	0.043	0.049	0.017	0.092	0.102	0.052	0.075	0.062
Days to fruit ripening	-0.019	0.004	-0.002	0.015	0.017	-0.037	0.008	0.009	0.002	0.011	0.011	-0.004	0.011	0.013	0.002	0.006	0.015
No. of fruits per plant	-0.036	0.072	0.036	0.070	0.091	-0.030	0.139	0.035	-0.003	-0.003	-0.015	0.020	0.046	0.082	0.082	0.082	0.011
Fruit length	0.005	-0.003	0.001	-0.006	-0.006	0.003	-0.003	-0.013	-0.005	-0.004	-0.007	-0.001	-0.005	-0.006	0.001	-0.001	-0.005
Fruit girth	0.012	-0.004	0.007	-0.008	-0.009	0.002	0.001	-0.011	-0.027	-0.012	-0.015	-0.005	-0.015	-0.005	0.006	0.003	-0.008
Fruit weight	-0.033	-0.003	0.002	0.030	0.026	-0.029	-0.002	0.033	0.045	0.102	0.066	0.004	0.058	0.030	-0.020	-0.017	0.033
100 pod weight	-0.012	0.003	-0.009	0.018	0.017	-0.017	-0.006	0.032	0.030	0.037	0.057	0.007	0.035	0.018	-0.015	-0.014	0.021
1000 seed weight	-0.009	-0.012	-0.013	-0.004	-0.006	-0.006	-0.009	-0.003	-0.012	-0.003	-0.007	-0.061	-0.002	-0.023	-0.006	-0.009	-0.001
No. of seeds per fruit	0.040	-0.025	-0.002	-0.047	-0.050	0.027	-0.030	-0.039	-0.049	-0.051	-0.056	-0.003	-0.091	-0.036	-0.013	-0.022	-0.022
Fresh yield / plant	-0.174	0.254	0.254	0.428	0.409	-0.244	0.401	0.299	0.119	0.199	0.213	0.257	0.270	0.678	0.232	0.230	0.261
Capsaicin	0.010	-0.020	-0.009	-0.011	-0.023	0.004	-0.045	0.006	0.015	0.015	0.021	-0.008	-0.011	-0.026	-0.076	-0.046	0.019
Oleoresins (%)	-0.014	0.023	0.123	0.017	0.025	-0.009	0.033	0.003	-0.007	-0.010	-0.014	0.008	0.014	0.020	0.034	0.057	-0.009
Capsanthin (EOA values)	0.018	-0.016	-0.002	-0.030	-0.024	0.027	-0.005	-0.028	-0.018	-0.026	-0.024	-0.001	-0.016	-0.026	0.017	0.011	-0.067
Dry pod yield / plant (Rp)	-0.278**	0.432**	0.447**	0.677**	0.692**	-0.393**	0.661**	0.408**	0.121	0.311**	0.273**	0.268**	0.415**	0.909**	0.324**	0.404**	0.340**

Residual effect : 0.200, Bold and diagonal values = direct effects Rp= Phenotypic correlation

** = Significant at 1% level

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Multivariate Analysis in Rice (*Oryza sativa* L.)

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ABSTRACT

Genetic divergence was assessed among thirty four genotypes of rice for twelve traits using Mahalanobis' D^2 statistic, cluster analysis and principal component analysis. On the basis of these culturing methods six clusters were obtained in both Mahalanobis' D^2 statistic and cluster analysis. In PCA five principal components were identified, out of which first four principal components explained 81.32% of variability in rice. The principal component analysis enabled loading of similar type of variables on a common principal component.

Key words : Rice, D^2 Analysis, Cluster Analysis, Principal Component Analysis

Rice is the most important crop after wheat and maize. Most of the people in Asia particularly in developing countries like India, meet their major calorific and protein requirement (75%) through rice. It forms a part of diet for 1/3 of the world's population either as direct food or as a part of their diet. The spectrum of variability in segregating generations depends on genetic diversity of the combining parents. Hence, estimation of the genetic diversity among genotypes is of immense importance for planning the future crossing programme. Mahalanobis' D^2 analysis, cluster analysis and principal component analysis are potent tools for estimating it.

MATERIAL AND METHODS

The present investigation was undertaken to assess the nature and magnitude of genetic diversity among 34 genotypes of rice (Table 1). The genotypes were planted in *rabi*, 2005-06 in randomized block design in Andhra Pradesh Rice Research Institute, Maruteru. Each genotype was raised following inter- and intra- row spacing of 25 x 30 cm. The biometrical observations were recorded on ten plants selected at random from the middle of the rows per genotype per replication for viz., plant height, ear bearing tillers / plant, panicle length, number of grains/panicle, number of filled grains / panicle, grain length, grain breadth and L/B ratio. Days to 50% flowering, test weight, protein content and yield /m^2 were recorded on plot basis. D^2 analysis (Mahalanobis, 1928), hierarchial cluster analysis (Anderberg, 1993) and principal component analysis (Jackson, 1991) were carried out using SPSS computer programme.

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant difference among the genotypes for twelve characters. This difference indicated the existence of significant amount of variability among the genotypes for the characters studied. On the basis of D^2 analysis and cluster analysis, the 34 genotypes were groped into six clusters (Table 2 and Fig.1). The variation in the composition of individual cluster with regard to the number of genotypes indicated the presence of large amount of diversity in the population. On the basis of D^2 analysis and cluster analysis, the scattering of genotypes from the same geographic region to different clusters might be due to the heterogeneity, genetic architecture of the populations, past history of selection, developmental traits and degree of general combining ability (Murthy and Arunachalam, 1966). The results have clearly indicated that there is no parallelism between the geographic diversity and genetic diversity in rice in accordance with Shanti and Singh (2001).

On the basis of D^2 analysis the maximum intra-cluster distance (D^2 value) was observed in cluster III (1417.64) and the minimum intra-cluster distance was observed in cluster V and VI (0.00) while on the basis of cluster analysis maximum intra-cluster distance was observed in cluster V (1411.88) and the minimum intra-cluster distance was observed in cluster III (228.88).

Inter-cluster distance was least between I and II (2277.46) and highest between IV and VI (19222.92) on the basis of D^2 analysis while, it was least between I and II (1462.14) and maximum between III and V (11975.77) on the basis of cluster analysis (Table 3). The hybridization

Table 1: Source of origin for 34 rice (Oryza sativa L.) genotypes under study.

S.No.	Genotype	Source
1	JGL 384	Jagitial, Andhra Pradesh
2	ARC 6605	Assam
3	TKM 6	Tamil Nadu
4	Annada	CRRI, Cuttack, Orissa
5	N22	Uttar Pradesh
6	Rajendra	ARI, Rajendra Nagar
7	MTU 1010	APRRI, Maruteru
8	Prasanna	DRR, Hyderabad
9	Pusa Basmati	IARI, New Delhi
10	Putikabari	Land race of Eastern Uttar Pradesh
11	Vandana	CRRI, Cuttack, Orissa
12	Rudrama	Rudrur, Andhra Pradesh
13	Naveen	CRRI, Cuttack, Orissa
14	Heera	CRRI, Cuttack, Orissa
15	Anjali	CRRI, Cuttack, Orissa
16	Aditya	DRR, Hyderabad
17	Rasi	DRR, Hyderabad
18	MTU 1006	APRRI, Maruteru
19	Dular	West Bengal
20	Ravi	DRR, Hyderabad
21	Lalnakanda 41	Punjab
22	MTU 1001	APRRI, Maruteru
23	Bhadraj	Not known
24	MTU 3626	APRRI, Maruteru
25	Salempiket	IRRI, Phillippines
26	IR 64	IRRI, Phillippines
27	Moroberkan	Guinea, West Africa
28	3626/Dular	--
29	1001/ Ravi	--
30	1001 / Bhadraj	--
31	3626 / Salempiket	--
32	IR 64 / Bhadraj	--
33	3626 / L41	--
34	1001 / MB	--

Table 2 : Mahalanobis' D² clustering of rice genotypes

Clusters	No. of genotypes	Genotypes
Cluster - I	9	Dular, Salempikit, Ravi, JGGL 384, IR 64/Bhadraj, 3626/Salempikit, MTU 3626, Pusa Basmati.
Cluster - II	10	Lalnakanda 41, 3626/ Dular, 3626 / Lalnakanda 41, 1001/Ravi, MTU 1001, IR 64, 1001/Bhadraj, 1001/ MB, Moroberkan, Bhadraj.
Cluster - III	11	Prasanna, Vandana, Rajendra, Anjali, MTU 1006, MTU 1010, Aditya, N22, Putikabari, Rudrama, Heera
Cluster - IV	2	ARC 6605, Annada
Cluster - V	1	TKM 6
Cluster - VI	1	Naveen

between genotypes from the clusters with medium inter-cluster distances should give rise to heterotic hybrids in subsequent segregating generations.

D² analysis indicated that the protein content (67.38%), length of the grain (19.61%), number of grains per panicle (4.81%), days to 50% flowering (4.28%), plant height (2.5%), test weight (1.07%) and yield per m² (0.36%) accounted for more than 90 per cent of total divergence in the material (Table 4). These results are in accordance with Shanti and Singh (2001). The additional advantage in hierarchial cluster analysis is identifying sub-cluster of the major groups at different levels so that each small group can be critically analysed.

Table 3: Inter- and intra cluster valeus of six clusters (based on D² analysis and cluster analysis) estimated for 34 genotypes of rice.

Cluster No.	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI
I (DA)	**1061.22**	2277.46	3212.29	3987.86	3807.17	7256.29
(CA)	**797.48**	1462.14	3712.81	5234.93	33706.93	1851.64
II (DA)		**767.74**	7746.88	2467.89	5393.98	13282.35
(CA)		**767.74**	2467.88	9690.64	7280.16	4014.90
III (DA)			**1417.64**	10926.33	3832.76	2444.58
(CA)			**228.88**	11662.87	11975.77	5160.31
IV (DA)				**228.89**	11520.17	19222.92
(CA)				**655.61**	2352.08	2476.09
V (DA)					**0.00**	3494.19
(CA)					**1411.88**	3050.43
VI (DA)						**0.00**
(CA)						**882.30**

Bold numbers indicate intra-cluster distance, DA indicates D² analysis values and CA indicates cluster analysis values.

In the principal component (PC) method, first four principal components (PC) showed eigen values more than one and they altogether explained 81.32% of the variability (Table 5) and they are significant while others are non-significant as eigen values are less than one (Legendre and Legendre, 1984). The first component explained 44.02% of the total variability in the set of the variables and remaining ones accounted for progressive lesser and lesser amount of variation.

Principal factor scores (PF scores) for all 34 genotypes were estimated in all the 4 PC's and utilized to construct precise 2D plot (Fig.2) and 3D plot (Fig.3). All the genotypes (names and number assigned are given in (Table 1) were plotted for PC$_1$, PC$_2$, PC$_3$ and PC$_4$ which clearly indicated the grouping of genotypes of same clusters falling nearer to each other. For example the genotypes Vandana and Rajendra of Cluster II fall nearer to each other on the positive axis of PC$_1$. Moroberkan and 3626/Dular from cluster II fall near to each other. While genotypes ARC 6605 (cluster III) and Annada (cluster III) fall away from

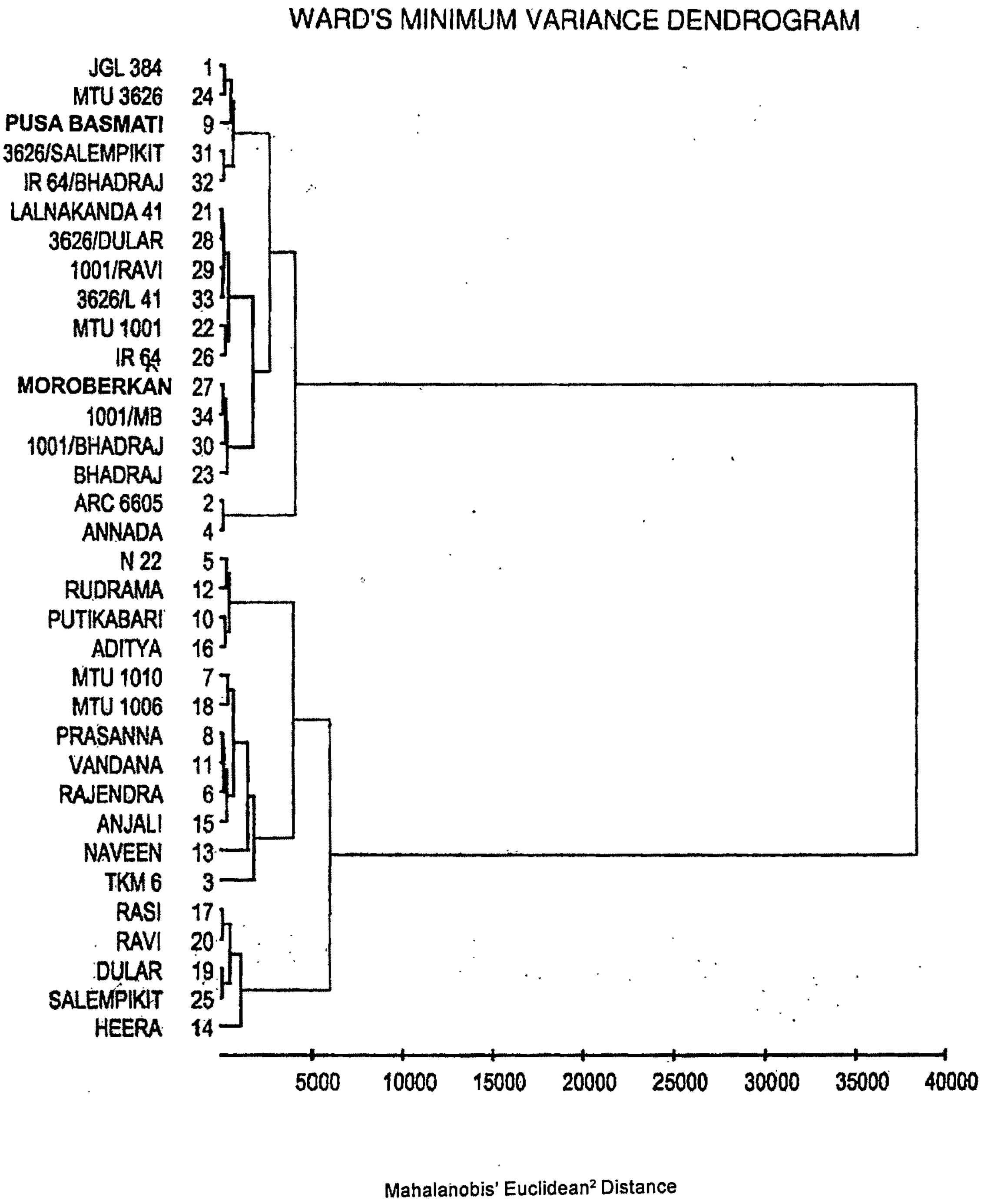

Fig 1 : Ward's minimum variance dendrogram of rice based on Euclidean² Distance

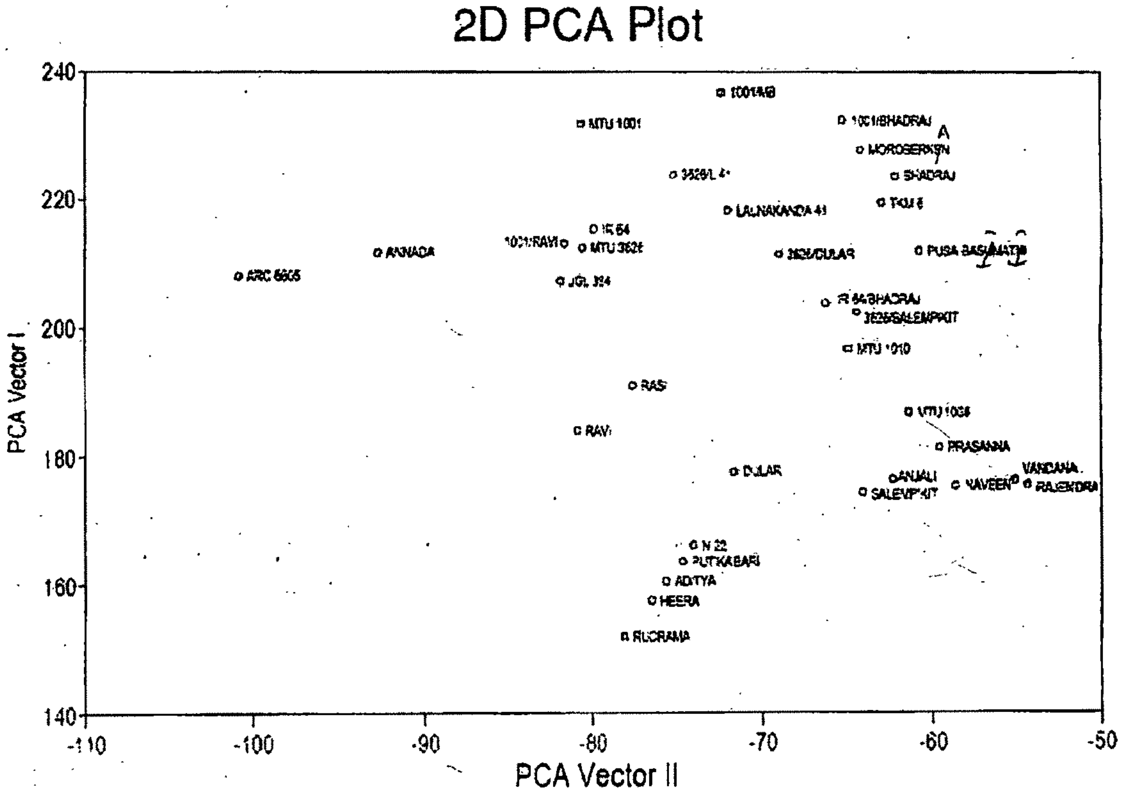

Fig 2: Two dimensional scattered diagram showing genotypes of rice based on PCA scores

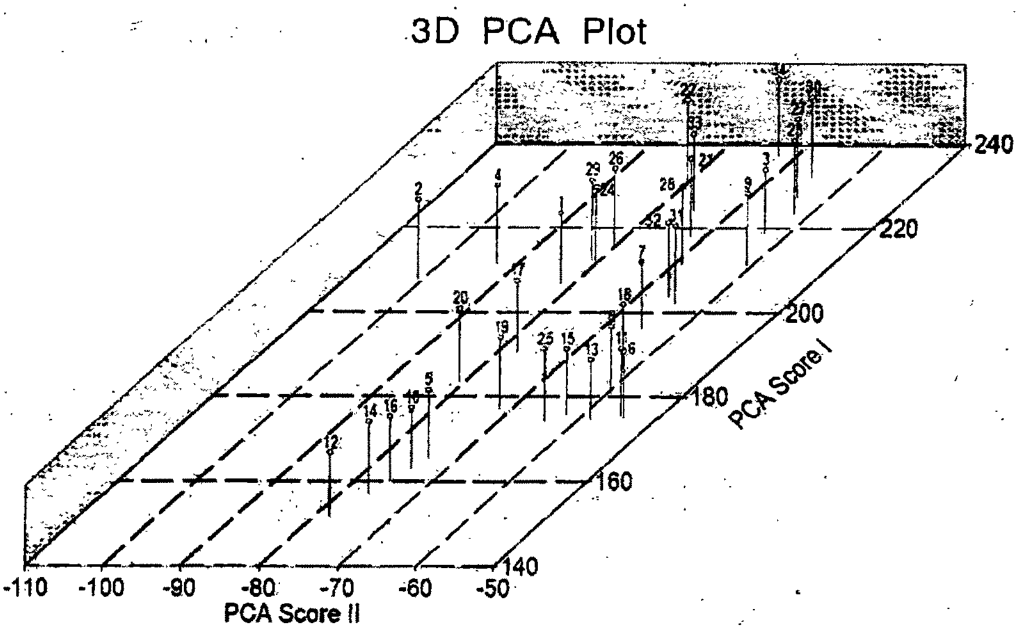

Fig 3: Three dimensional plot showing scattering of genotypes of rice based on PCA scores

Table 4 : Contribution of different characters towards genetic divergence (D^2) in 34 genotypes of rice.

Character	Rank	Contribution (%)
Plant height	5	2.50
Days to 50% flowering	4	4.28
Number of grains / planicle	3	4.81
Test weight (g)	6	1.07
Yield / m^2	7	0.36
Length of the grain (mm)	2	19.61
Protein (%)	1	67.38

Table 5: Eigen value, per cent and cumulative variance in rice for 5 principal components.

Character	PC_1	PC_2	PC_3	PC_4	PC_5
Root	5.283	2.343	1.117	1.014	0.663
% variance absorbed	44.02	19.52	9.31	8.45	5.53
Cumulative total percent variation	44.02	63.55	72.87	81.32	86.85

other genotypes indicating their specificity in clustering, when PC_1, PC_2, PC_3 were considered simultaneously superior for all the characters which three of these factors represented.

The results of hierarchial cluster analysis and PCA confirmed the findings of each other. The plot of PC_1, PC_2, PC_3 and PC_4 accounted for 81.32% of variation which showed clear differentiation of genotypes according to their cluster membership. Genotypes belonging to a common cluster have fallen nearer to each other and vice-versa and this confirms the results of cluster analysis.

All the three methods of grouping revealed a single concept of non-correspondence of genetic and geographic diversities. All the three methods of classifying genotypes into different groups are equally useful but hierarchial cluster analysis gave an additional advantage of identifying sub-cluster of the major groups at different levels so that each small group can be critically analysed.

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Application of Principal Component and Cluster Analyses in Chilli (*Capsicum annuum* L.)

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ABSTRACT

Sixty genotypes of chilli were evaluated for 18 different characters to study genetic divergence by using principal component and cluster analyses. Out of 18 principal components (PCS), first seven PCS accounted for 77.42 per cent of total variability thus reducing the dimensionality of the data system. The first PC which explained the maximum variability of 23.65 per cent was significantly correlated with days to 50% flowering, fresh fruit yield per plant, days to 50% fruit ripening, number of fruits per plant and capsanthin content. The hierarchical cluster analysis by Ward's minimum variance method classified the 60 genotypes into 8 clusters based on their PCA scores. Cluster analysis revealed wide genetic distance between cluster V and VII followed by cluster VI and VIII and cluster I and VII. Therefore, during hybridization programme, selection of parents from these clusters will produce superior segregants.

Key words : Chilli, Principal Component Analysis, Cluster Analysis and Ward's Minimum Variance

Chilli is the second largest commodity after black pepper in international spice trade. In India the crop occupies the largest area among all the spices. Apart from its value as spice chilli has many medicinal properties which are yet to be fully exploited. Chilli is now gaining more importance in the global market because of its value added product like chilli powder, oleoresin, capsanthin and capsaicin.

When there is no substantial variability or when the available variability is exhausted through selection new variability has to be created through hybridization. This calls for identification of genetically divergent groups in the species, as crosses involving parents from widely divergent groups are very much likely to yield desirable genotypes. Therefore, an investigation was carried out, to estimate the nature and degree of genetic divergence, to reduce the number of attributes of importance to the essential ones, to comprehend the nature of the association among the attributes and to group the genotypes into various clusters to establish a solid base for future chilli hybridization programme.

MATERIAL AND METHODS

Sixty genotypes of chilli (*Capsicum annuum* L.) comprising established varieties, advanced true breeding lines and local collections were used as the experimental material. Genotypes accession number with their respective source are presented in Table 1. These genotypes were grown in a randomized complete block design with three replications during *kharif* 2005-06 at Regional Agricultural Research Station, Lam Farm, Guntur. Each genotype was grown in four rows of 5 m length with inter- and intra-row spacing of 60 x 30 cm. The data were recorded on five random plants from each genotype in each replication for 18 characters viz., plant height (cm), plant spread (cm), number of branches per plant, number of fruits per plant, fruit length (cm), fruit girth (cm) and number of seeds per fruit. However, days to 50% flowering, days to 50% fruit ripening, days to maturity, 1000 seed weight (g), oleoresin content (%), capsanthin content (EOA colour value), capsaicin content (%), 100 fresh pod weight (g), 100 dry pod weight (g), fresh fruit yield per plant (g) and dry fruit yield per plant (g) were recorded on plot basis. The mean values were subjected to standard statistical procedures.

In the present study, PCA was performed by using SPSS Software on the correlation matrix of traits there by removing the effect of scale (Jackson, 1991). Cluster analysis classifies a set of observations into two or more mutually exclusive unknown groups based on combinations of interval variables. Agglomerative hierarchical clustering technique (Ward's minimum variance) was followed for cluster analysis as given by Anderberg (1993).

RESULTS AND DISCUSSION

Principal components (eigen value greater than one), eigen values (Latent root), per cent variability, cumulative per cent variability and component loading of different characters are presented in Table 2.

Table 1: Accession number and source of 60 chilli genotypes.

S.No.	Accession Number	Source
1	LCA-606	Selection from O.P variety collected from Bellary
2	LCA-348	Selection from O.P variety of Lam, Guntur
3	LCA-386	Selection from O.P variety of Khammam
4	LCA-387	Selection from O.P variety of Khammam
5	LCA-353	Pedegree slection from cross derivative developed at Lam
6	LCA-388	Selection from O.P variety of Khammam
7	LCA-389	Selection from O.P variety of Khammam
8	LCA-315	Pedegree slection from cross derivative developed at Lam
9	LCA-960	Selection from Hungarian paprika developed at Lam, Guntur
10	LCA-392	Selection from O.P variety of Khammam
11	LCA-357	Selection from O.P variety of Lam, Guntur
12	LCA-334	Pedegree slection from cross derivative developed at Lam
13	LCA-333	Selection from O.P variety of Lam, Guntur
14	LCA-372	Selection from O.P variety of Lam, Guntur
15	LCA-356	Selection from O.P variety of Lam, Guntur
16	LCA-379	Selection from O.P variety of Lam, Guntur
17	LCA-385	Selection from O.P variety of Khammam
18	LCA-362	Selection from O.P variety of Lam, Guntur
19	LCA-358	Selection from O.P variety of Lam, Guntur
20	LCA-381	Selection from O.P variety of Warangal
21	LCA-391	Selection from O.P variety of Warangal
22	LCA-369	Selection from O.P variety of Lam, Guntur
23	LCA-390	Selection from O.P variety of Warangal
24	LCA-393	Selection from O.P variety of Warangal
25	LCA-394	Selection from O.P variety of Lam, Guntur
26	LCA-424	Selection from Hyderabad local paprika
27	LCA-373	Selection from O.P variety of Lam, Guntur
28	LCA-609	Selection from O.P variety collected from Bellary
29	LCA-375	Selection from O.P variety of Lam, Guntur
30	LCA-378	Selection from O.P variety of Lam, Guntur
31	LCA-395	Selection from O.P variety of Lam, Guntur
32	LCA-396	Selection from O.P variety of Lam, Guntur
33	LCA-397	Selection from O.P variety of Lam, Guntur
34	LCA-398	Selection from O.P variety of Lam, Guntur
35	LCA-399	Selection from O.P variety of Lam, Guntur
36	LCA-600	Selection from O.P variety collected from Bellary
37	LCA-602	Selection from O.P variety collected from Bellary
38	LCA-604	Selection from O.P variety collected from Bellary
39	LCA-605	Selection from O.P variety collected from Bellary
40	LCA-607	Selection from O.P variety collected from Bellary
41	LCA-608	Selection from O.P variety collected from Bellary
42	Aparna	Selection from Gollaprolu local from East Godavari
43	LCA-610	Selection from O.P variety collected from Bellary
44	LCA-611	Selection from O.P variety collected from Bellary
45	LCA-612	Selection from O.P variety collected from Bellary
46	LCA-613	Selection from O.P variety collected from Bellary
47	LCA-614	Selection from O.P variety collected from Bellary
48	LCA-615	Selection from O.P variety collected from Bellary
49	LCA-616	Selection from O.P variety collected from Raichur
50	LCA-617	Selection from O.P variety collected from Raichur
51	LCA-618	Selection from O.P variety collected from Raichur
52	LCA-619	Selection from O.P variety collected from Raichur
53	LCA-620	Selection from O.P variety collected from Raichur
54	LCA-621	Selection from O.P variety collected from Raichur
55	LCA-622	Selection from O.P variety collected from Raichur
56	LCA-603	Selection from O.P variety collected from Raichur
57	LCA-623	Selection from O.P variety collected from Raichur
58	LCA-624	Selection from O.P variety collected from Raichur
59	LCA-625	Selection from O.P variety collected from Raichur
60	LCA-601	Selection from O.P variety collected from Bellary

In the present study, the first seven principal components with eigen values more than one contributed 77.42 per cent towards the total variability. Principal components (8-18) had eigen values less than one which were considered as non-significant (Legendre and Legendre, 1984). It was therefore inferred that the essential features of data set had been represented in the first seven principal components. These results are in accordance with the reports of Usha Rani (1997) where similar 7 principal components were formed to describe the maximum variance of the data set.

First principal component described maximum variability (23.65%). Characters *viz.*, days to 50% flowering, fresh fruit yield per plant, days to 50% fruit ripening, number of fruits per plant and capsanthin content explained maximum variance in first principal component. The characters days to 50% flowering, days to 50% fruit ripening, capsanthin content had positive weight where as fresh fruit yield per plant and number of fruits per plant had negative weight. This suggests that the accessions that emphasize on more fresh fruit yield per plant with more number of fruits per plant tend to have less capsanthin (EOA colour value).

The second principal component (PC_2) accounting for 14.37 per cent of total variability. This component reflected significant loadings of 100 dry pod weight, 100 fresh pod weight, dry fruit yield per plant and capsaicin content and all these characters except capsaicin content contributed positively to this component suggesting that genotypes with low capsaicin content tend to have more dry fruit yield per plant. The third principal component (PC_3), which described 10.76 per cent contribution towards total variability, reflected significant loading of oleoresin content and plant spread. The quality character oleoresin had a positive correlation thus signifying its importance in fruit production, whereas plant spread had negative correlation. Number of seeds per fruit showed significant loading value in fourth principal component (PC_4) which is accounting for 9.15 per cent of total variability. The fifth principal component (PC_5) described 7.12 per cent of total variability. Days to maturity and fruit girth showed significant loading values but days to maturity was positively correlated indicating late maturing genotypes had more yield. The sixth principal component (PC_6) having positive significant loading of 1000 seed weight described 6.48 per cent of total variance. So, 1000 seed weight reflects as one of the yield potential of each genotype. The last significant

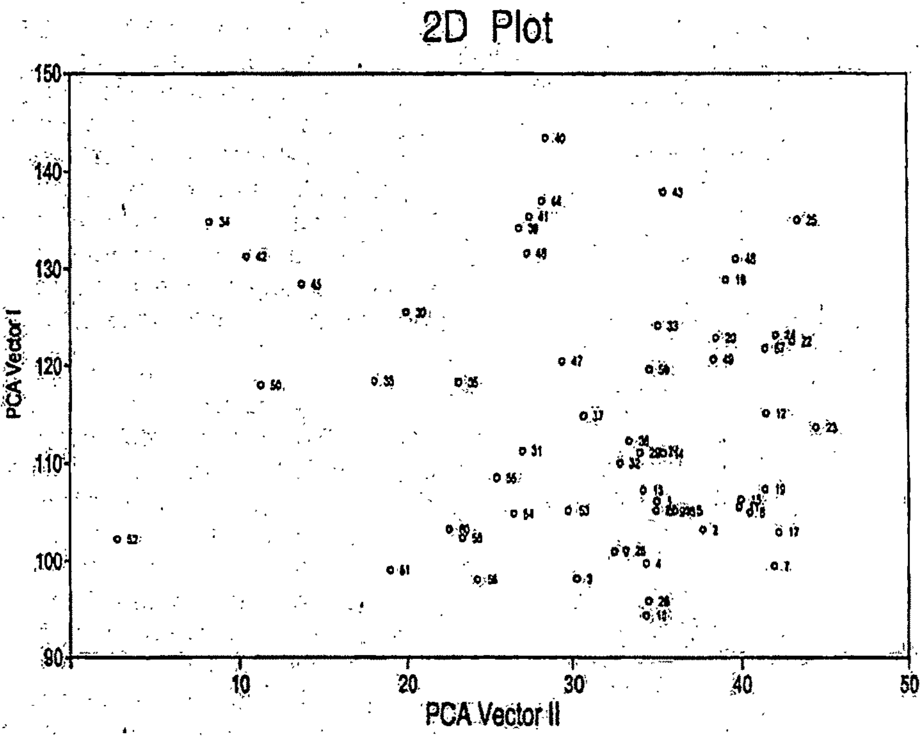

Fig 1: Two dimensional graph showing relative position of chilli (*Capsicum annuum* L.) genotypes based on PCA score.

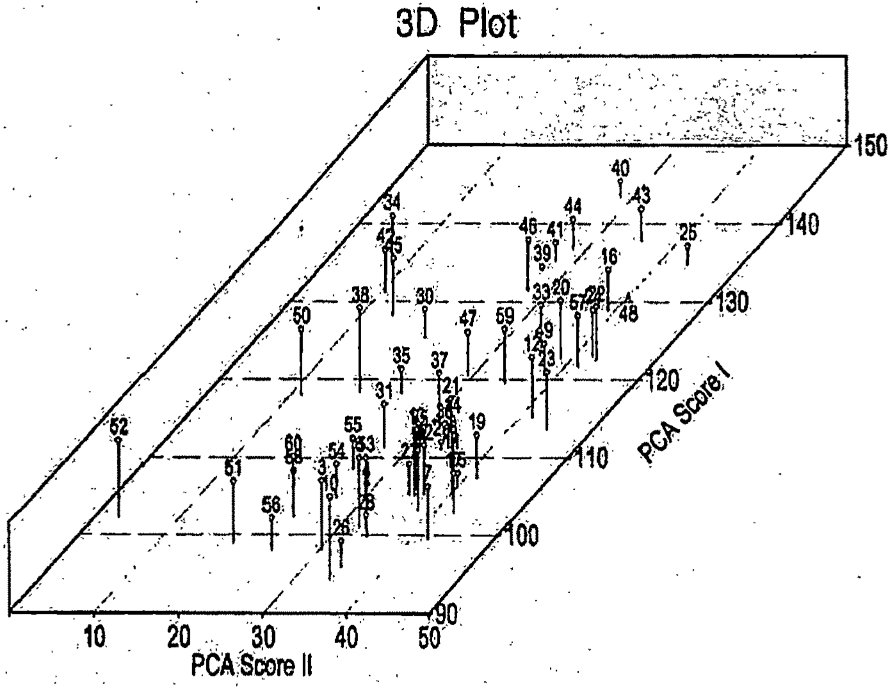

Fig 2: Three dimensional graph showing relative position of chilli (*Capsicum annuum* L.) genotypes based on PCA score.

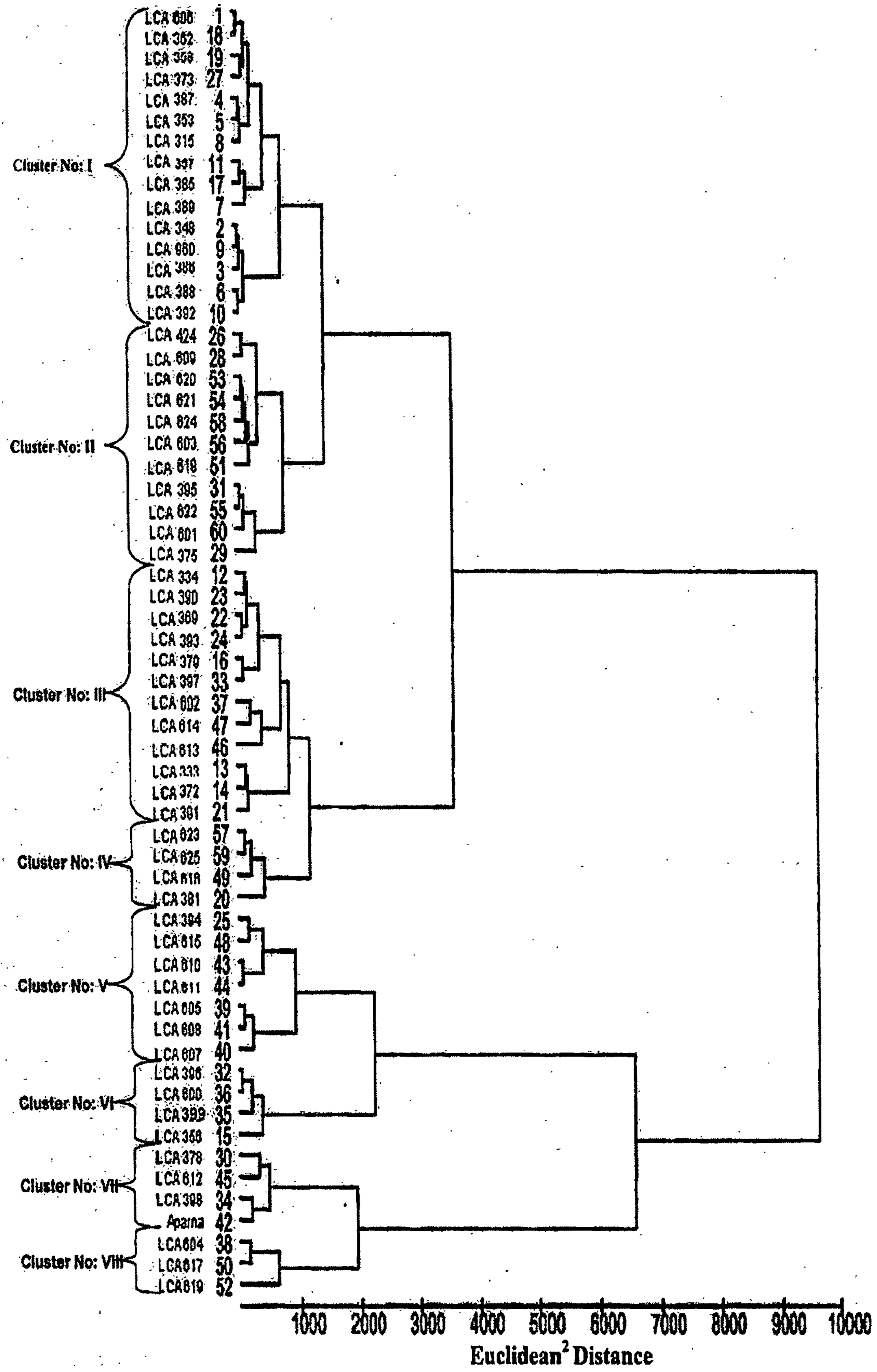

Fig 3: Dendrogram showing relationship of 60 chilli (*Capsicum annuum* L.) genotypes in VIII clusters

Table 2: Eigen values, proportion of the total variability represented by first seven principal components, cumulative per cent variability and component loading of different characters in chilli (Capsicum annuum L.).

	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6	PC_7
Eigen value (Root)	4.258	2.587	1.938	1.648	1.283	1.153	1.070
% Varability explained	23.658	14.375	10.768	9.155	7.126	6.404	5.942
Cum. variability explained	23.658	38.033	48.801	57.955	65.081	71.485	77.427
Days to 50% flowering	0.385	0.089	0.110	0.073	0.055	0.135	0.003
Days to 50% fruit ripening	0.356	0.136	0.062	-0.171	-0.069	-0.018	-0.196
Days to maturity	0.212	0.215	-0.046	0.250	0.423	0.376	-0.018
Plant height (cm)	-0.055	0.188	-0.178	-0.282	0.348	0.023	-0.552
Plant spread (cm)	0.164	-0.206	-0.424	-0.184	0.167	0.086	-0.046
No. of branches / plant	0.273	0.288	0.312	-0.219	-0.036	0.033	-0.025
No. of fruits / plant	-0.317	0.094	0.148	-0.156	0.026	0.481	-0.195
Fruit ength (cm)	0.222	0.027	0.012	-0.240	-0.017	0.102	0.091
Fruit girth (cm)	-0.087	0.208	0.191	0.127	-0.459	-0.263	-0.540
No. of seeds / fruit	0.147	-0.106	0.159	0.500	0.113	0.030	0.053
1000 seed weight (g)	-0.059	0.059	0.208	-0.094	-0.380	0.546	0.259
Oleoresin content (%)	-0.075	-0.089	0.449	-0.356	0.380	-0.178	0.087
Capsanthin (EOA colour value)	0.314	-0.071	-0.217	-0.059	-0.285	0.306	-0.234
Capsaicin content (%)	0.115	-0.454	0.111	0.303	-0.003	0.079	-0.310
100 - fresh pod weight (g)	0.235	0.343	0.259	0.275	0.168	-0.100	-0.026
100 - dry pod weight (g)	-0.085	0.527	-0.234	0.051	-0.098	-0.114	0.240
Fresh fruit yield / plant (g)	-0.386	-0.011	0.261	0.119	0.145	0.237	-0.159
Dry fruit yield / plant (g)	-0.254	0.291	-0.307	0.265	0.098	0.103	-0.063

Table 3: Clustering of 60 chilli (Capsicum annuum L.) genotypes by Ward's minimum variance method.

Cluster No.	No. of genotypes	Name of genotypes
I	15	LCA 606, LCA 362, LCA 358, LCA 373, LCA 387, LCA 353, LCA 315, LCA 37, LCA 385, LCA 389, LCA 348, LCA 960, LCA 386, LCA 392.
II	11	LCA 424, LCA 609, LCA 620, LCA 621, LCA 624, LCA 603, LCA 618, LCA 395, LCA 622, LCA 601, LCA 375
III	12	LCA 334, LCA 390, LCA 369, LCA 393, LCA 379, LCA 397, LCA 602, LCA 614, LCA 613, LCA 333, LCA 372, LCA 391.
IV	4	LCA 623, LCA 625, LCA 616, LCA 381
V	7	LCA 394, LCA 615, LCA 615, LCA 610, LCA 611, LCA 605, LCA 608, LCA 607
VI	4	LCA 396, LCA 600, LCA 398, LCA 356
VII	4	LCA 378, LCA 612, LCA 398, Aparna
VIII	3	LCA 604, LCA 617, LCA 619

principal component by negative and high loading value of plant height. PC_7 described 5.94 per cent of total variance.

The PCA scores of 60 chilli genotypes were plotted in graph to get the 2 D and 3 D scattered diagram (Fig. 1 and Fig.2). These graphs showed wide divergence between the genotypes. LCA 619 and LCA 617 showed wide distance from LCA 394 and LCA 615 and signifying their use in chilli breeding.

The principal component scores of genotypes wee used as input for clustering procedures in order to group the genotypes into various clusters and to confirm the results of principal component analysis. Hierarchical clustering (Ward's minimum variance) method was followed to create dendrogram (Fig.3) based on Euclidean^2 distance (dissimilarity coefficients). The 60 genotypes were grouped into 8 clusters (Table 3). Distribution of various genotypes into clusters was random indicating that the geographical diversity and genetic diversity were not related. Among all the clusters, cluster I was the largest containing 15 genotypes followed by cluster III with 12 genotypes and cluster II with 11 genotypes. The average intra- and inter-cluster Euclidean^2 distance were estimated based on Ward's minimum variance and are presented in Table 4.

Of the 8 clusters formed, maximum intra- cluster distance as Euclidean^2 distance was recorded in cluster VIII (777.06), followed by cluster VII (628.49) and cluster V (609.91). The maximum inter-cluster distance was observed between cluster V and cluster VIII (3643.06), followed by cluster VI and cluster VIII (2941.9) and cluster I and cluster VII (2930.59). This suggest that there is wide genetic diversity between these clusters. Based on inter- cluster distances, crosses can be made between genotypes of these clusters to obtain better and desirable segregants.

Results of cluster analysis based on PCA scores were compared with the results of the principal component analysis on a visual aid in desecrating clusters in the 2 D and 3 D scattered diagrams. The genotypes falling in the same cluster, are closer to each other in scattered diagrams. Brown (1991) and Altaher and Singh (2003) also studied the utilization of principal component analysis combined with clustering of Ward's method in genetic divergence studies in cotton.

Cluster means were computed for the 18 characters studied on pooled basis and are presented in Table 4. Out of 8 cluster I recorded high mean values for most of important economic attributes like number of fruits per plant, fresh fruit

Table 4: Inter- and intra-cluster squared Euclidean distance between eight clusters formed by Ward's minimum variance method in 60 chilli (Capsicum annuum L.) genotypes.

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VIII
Cluster I	**376.40**	617.84	826.97	926.71	23973.90	1158.37	2930.59	2257.42
Cluster II		**463.92**	1026.10	1127.79	2315.04	1051.56	2352.44	1739.19
Cluster III			**599.42**	850.80	1254.17	1031.55	2026.86	2397.19
Cluster IV				**489.34**	2026.20	1828.57	2661.21	2198.79
Cluster V					**609.91**	1285.74	1649.97	3643.06
Cluster VI						**396.11**	2063.86	2941.90
Cluster VII							**628.49**	1617.57
Cluster VIII								**777.06**

Bold number in the diagonal indicates Inra-cluster distance.

Table 5 : Mean values of eight clusters (obtained by Ward's method) esstimated from 60 genotypes of chilli (Capsicum annuum L.) for 18 characters.

	Days to 50% flower-ing	Days to 50% fruit ripen-ing	Days to matu-rity	Plant height (cm)	Plant spread (cm)	No. of bran-ches/ plant	No. of fruits/ plant	Fruit length (cm)	Fruit girth (cm)	No. of seeds/ fruit	1000 seed wt. (g)	Oleo-resin content (%)	Capsan-thin (EOA colour value)	Capsa-icin content (%)	100 fresh pod weight (g)	100 dry pod weight (g)	Fresh fruit yield plant (g)	Dry fruit yield / plant (g)
Cluster I	53.84	117.60	152.26	96.73	99.60	4.04	181.97	8.31	3.73	70.68	4.25	9.68	22394.89	0.19	209.73	83.23	356.74	141.26
Cluster II	50.84	110.30	144.39	87.07	118.72	3.27	101.78	7.97	3.65	70.18	4.08	8.15	26160.00	0.31	169.10	71.36	172.85	70.152
Cluster III	61.13	133.16	163.83	95.36	106.97	4.11	159.97	8.33	3.73	77.83	4.92	9.34	37128.61	0.21	214.54	88.06	316.12	128.80
Cluster IV	62.41	136.08	172.91	87.00	111.50	3.70	95.41	7.89	3.21	81.25	4.43	9.73	15852.50	0.24	204.90	81.85	197.93	80.16
Cluster V	67.19	141.71	172.23	93.09	118.57	3.63	107.52	9.54	3.62	77.23	4.07	7.71	69015.23	0.25	200.00	87.49	181.08	78.09
Cluster VI	53.58	111.16	150.75	88.20	123.75	3.63	147.25	8.26	3.47	81.66	4.51	7.20	60045.00	0.22	203.03	88.31	251.30	107.33
Cluster VII	64.33	135.50	167.91	82.41	116.25	3.49	151.58	8.07	3.47	82.08	4.35	8.30	61433.33	0.67	176.28	74.81	255.82	106.0
Cluster VIII	55.55	121.00	155.88	94.33	111.00	3.08	109.88	8.76	3.52	94.33	4.53	10.20	21857.77	0.73	211.83	77.57	304.88	117.00

yield per plant, dry fruit yield per plant where as it also showed low mean value for capsaicin content. So, it was therefore, inferred that genotypes in this cluster were high yielder with low pungent type. Among the quality attributes high mean values for oleoresin and capsaicin content were recorded in cluster VIII. So, the genotypes in this cluster can be used for extraction of oleoresin coupled with high pungency. Cluster VI recorded low mean value for oleoresin. So, the crosses between cluster VI and VIII may produce transgressive segregants for oleoresin content. As far as capsanthin is concerned cluster V recorded high mean value.

Agglomerative cluster analysis revealed that wide genetic distance between cluster V and VII followed by cluster VI and VIII and cluster I and cluster VII. Therefore, during hybridization programme, selection of parents from these clusters will produce superior segregants.

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Multivariate Analysis in Soybean [*Glycine max* (L.) Merrill]

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ABSTRACT

Thirty eight genotypes of soybean were evaluated for genetic diversity using Mahalanobis' D^2 statistics and grouped into nine dusters. Days to maturity contributed maximum towards genetic divergence followed by plant height and oil per cent. Hierarchical cluster analysis resulted into seven clusters containing one to ten genotypes. The best cluster with regard to seed yield and oil content was cluster I. Principal factor analysis identified five principal components which explained 79.39 per cent variability in soybean.

Key words : Soybean, D^2 Analysis, Cluster Analysis, Principal Factor Analysis

Soybean [*Glycine max* (L.) Merrill] is the most important and valuable oil seed crop cultivated world wide on account of its unique nutritional value and chemical composition, functional health benefits, wide range of geographical adaptation and versatile end uses as food, feed and raw material for industry.

Utilization of genetic resources in developing sustainable solutions to basic crop constraints have been suggested from time to time but these genetic resources could not be exploited fully due to their inherent problems of lack of sufficient evaluation and classification (Dahiberg, 1995). For effective utilization of these resources, it is necessary to evaluate and characterize them. Therefore, the present investigation was undertaken in soybean to have an understanding about the divergence pattern, in a set of soybean genotypes.

MATERIAL AND METHODS

The present investigation was conducted on 38 soybean genotypes (Table 1) at Regional Agricultural Research Station, Lam, Guntur during *kharif*, 2005 in randomized complete block design with three replications. Each genotype was sown in a single row with a length of 4m and inter- and intra-row spacing of 30x7.5 cm in black cotton soil. Five randomly selected plants were used per genotype per replication for recording observations on plant height (cm), branches per plant, pods per plant, pod length (cm), seeds per pod, biological yield per plant (g), harvest index (%) and seed yield per plant (g). While plot means were used for days to 50% flowering, days to maturity, 100 seed weight (g), protein content (%) and oil content (%). D^2 analysis (Mahalanobis, 1928), hierarchical cluster analysis (Anderberg, 1993) and principal component analysis (Jackson, 1991) were carried out using SPSS computer programme.

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant difference among the genotypes for thirteen characters. This difference indicated the existence of significant amount of variability among the genotypes for the characters studied. On the basis of D^2 analysis (Table 2) and cluster analysis, the 38 genotypes were grouped into nine clusters (Fig.1). The variation in the composition of individual cluster with regard to the number of genotypes indicated the presence of large amount of diversity in the population. On the basis of D^2 analysis and cluster analysis, the scattering of genotypes from the same geographic region to different clusters might be due to the heterogeneity, genetic architecture of the populations, past history of selection, developmental traits and degree of general combining ability (Murthy and Arunachalam, 1966). The results have clearly indicated that there is no parallelism between the geographic diversity and genetic diversity in soybean. This is in accordance with the findings of Raut *et. al.* (1984) and Ghatge and Kadu (1983).

On the basis D^2 analysis, the minimum intra cluster distance (D value) was zero (cluster III, IV, V, VI VII and IX) and was maximum in cluster I (87.36) while on the basis of cluster analysis it was zero in cluster VII and maximum in cluster V (86.94). Similarly, the least inter- cluster distance was observed between cluster IV and VI (57.36) while the highest between IV and V (554.63) on the basis of D^2 analysis while, it was least between cluster I and III (83.49) and was maximum between cluster III and VII (426.16) on the basis of cluster analysis (Table 3 and 4). The

Table 1: Source of origin for 38 soybean genotypes under study.

S.No.	Genotypes	Source
1	RSC 18	Raipur
2	DS 2206	Delhi
3	AMS 99-24	Amaravathi
4	MACS 1028	Pune
5	VLS 64	Almora
6	SL 751	Ludhiana
7	RKS 25	Kota
8	AMS 353	Amaravathi
9	MACS 1038	Pune
10	VLS 63	Almora
11	SL 717	Ludhiana
12	RKS 34	Kota
13	DS 2207	Delhi
14	JS 99-72	Jabalpur
15	SL 733	Ludhiana
16	MACS 1058	Pune
17	AMS 47	Amaravathi
18	DSB 8	Dharwad
19	HIMSO 1604	Palmpur
20	JS 99-71	Jablpur
21	HIMSO 1603	Palmpur
22	TS 42	Trombay
23	HIMSO 1605	Palmpur
24	MAUS 222	Parbhani
25	TS 58	Trombay
26	PS 1403	Pantnagar
27	MAUS 231	Parbhani
28	NRC 72	Indore
29	MAUS 49-1-2	Parbhani
30	PS 1398	Pantnagar
31	NRC 71	Indore
32	PS 1409	Pantnagar
33	NRC 70	Indore
34	PS 1410	Pantnagar
35	TNAUS 55	Coimbatore
36	Bragg	Introduced from USA
37	MACS 450	Pune
38	JS 335	Jabalpur

Table 2 : Distribution of 38 soybean genotypes in different clusters based on D^2 analysis.

Cluster No.	No. of gentypes	Genotypes
1	26	MACS 1038, JS 335, AMS99-24, SL751, AMS353, SL717, NRC70, NRC71, NRC72, MACS1028, Bragg, TS42, PS1398, PS1403, PS1409, VLS63, DS2206, HIMSO1604, SL733, PS1410, VLS64; DSB8, RSC18, TS58, MACS1058, RKS34
2	3	JS99-71, HIMSO1605, HIMSO1603
3	1	MACS450
4	1	JS99-72
5	1	MAUS231
6	1	MAUS222
7	3	AMS47, MAUS49-1-29, DS2207
8	1	RKS25
9	1	TNAUS-55

hybridization between genotypes from the clusters with medium to maximum inter- cluster distances should give rise to heterotic hybrids in subsequent segregating generations.

Table 3: Intra-and inter-cluster distance values of 9 clusters (based on D2 analysis) estimated for 38 soybean genotypes.

Cluster number	I	I	III	IV	V	VI	VII	VIII	IX
I	**87.36**	312.37	142.88	126.07	147.43	138.18	154.08	145.95	397.58
I		**47.88**	492.77	280.07	456.56	395.14	436.50	413.35	345.01
III			**0.00**	198.54	25.22	152.68	242.06	89.58	411.97
IV				**0.00**	150.60	57.36	139.55	172.48	222.19
V					**0.00**	89.48	109.42	344.83	321.50
VI						**0.00**	91.88	197.65	203.53
VII							**62.55**	252.70	414.97
VIII								**0.00**	554.63
IX									**0.00**

Values in the bold indicate intra-cluster distances.

The additional advantage of D^2 analysis in estimation of the contribution of various characters towards the expression of the genetic divergence (Table 5). This analysis indicated that days to maturity (20.63), plant height (20.34), oil content (15.08), protein content (14.08), pods per plant (13.66) and days to 50 per cent flowering (12.52) accounted for more than 90 per cent of total divergence in the material. These results are on par with those of Raut *et. al.* (1984) and Ghatge and Kadu (1993). While the additional advantage in hierarchical cluster analysis is identifying sub-cluster of the major groups of different levels so that each small group can be critically analysed.

In the present investigation, principal component (PC) method was used to extract the principal factor (PF) as it does not require the assumption of normal distribution of population. The PC's with eigen values > 1 were retained and < 1 were considered non-significant (Legendre and Legendre, 1984). The first 5 PC's showed eigen values more than one and they altogether explained 79.39% of the variability (Table 6). The first PC explained 25.77% of the total variability in the set of all variables and remaining ones accounted for progressively lesser and lesser amount of variation.

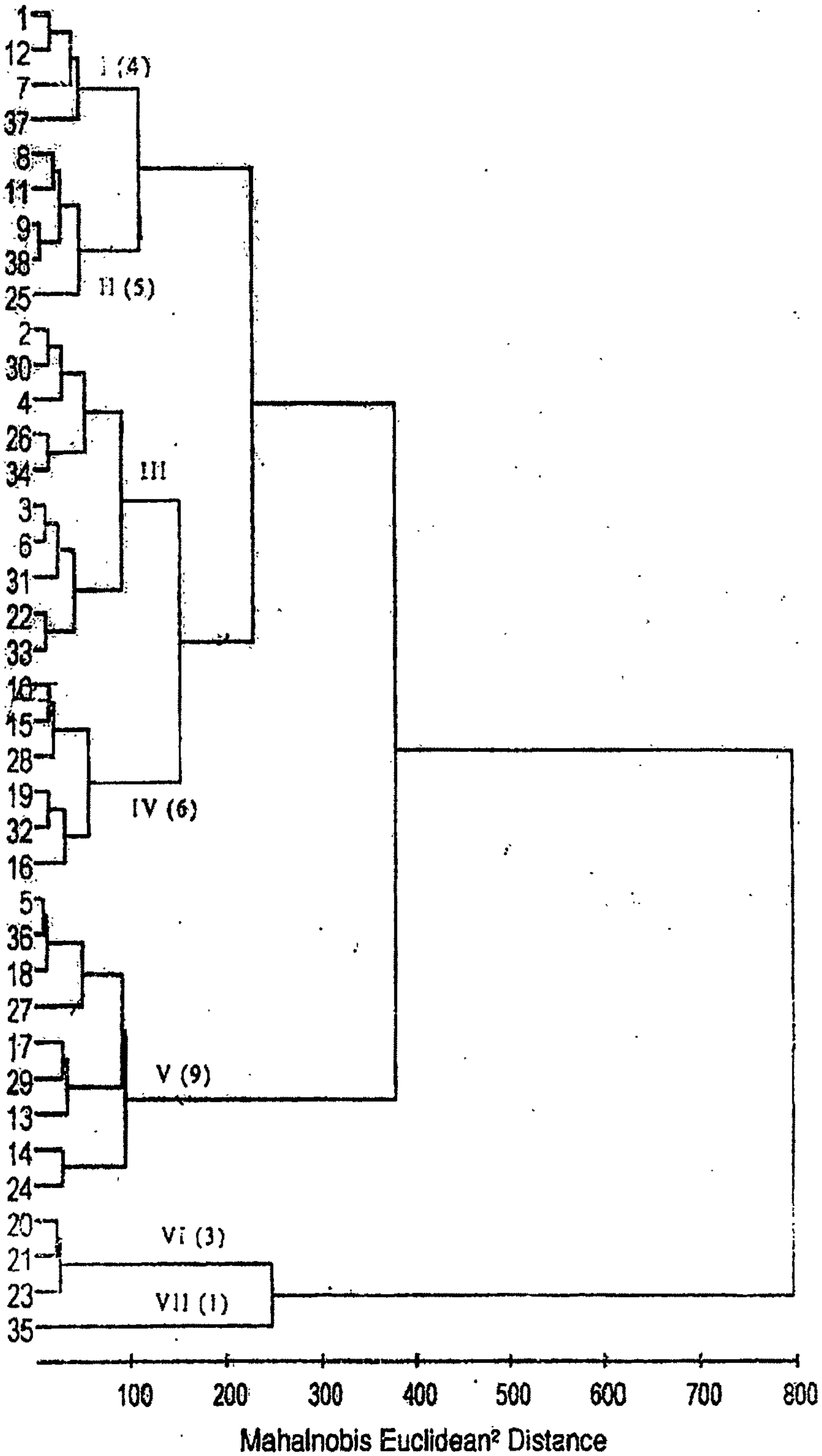

Fig 1: Dendrogram portraying hierarchical clustering pattern of 38 soybean genotypes (As per Table 1). Roman num bers indicate cluster numbers, numbers in parantheses indicate total genotypes in that

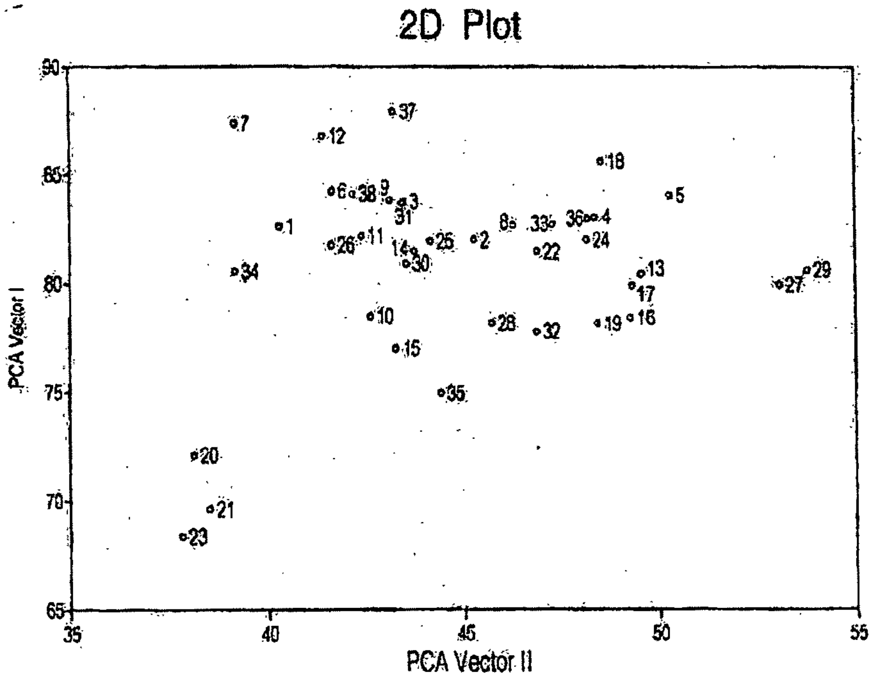

Fig.2 : 2D Plot showing scattering of 38 soybean genotypes (As per Table 1)

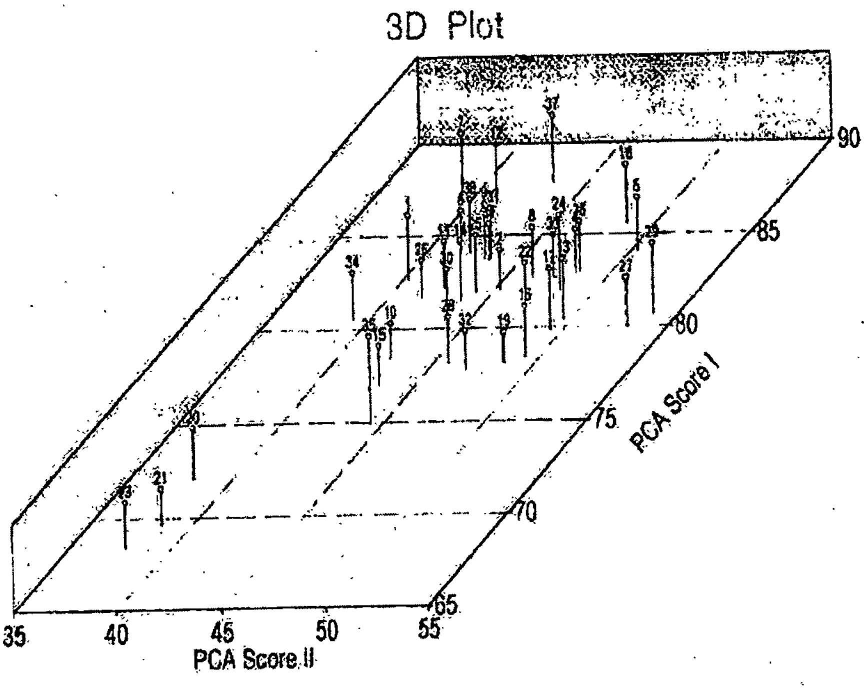

Fig. 3: 3D Plot showing scattering of 38 soybean genotypes (As per Table 1) based on PCA scores.

Table 4: Intra- and inter- cluster distance values of 7 clusters (based on cluster analysis) estimated for 38 soybean genotypes.

Cluster number	I	II	III	IV	V	VI	VII
I	**70.965**	97.634	115.003	194.02	172.877	400.696	409.164
II		**51.777**	83.499	87.873	133.592	322.369	396.427
III			**64.472**	91.935	132.01	31.155	426.169
IV				**54.013**	140.443	231.652	372.118
V					**86.944**	412.535	353.615
VI						**47.883**	345.009
VII							**0.000**

Values in the bold letters indicate intra-cluster distances.

Table 5 : Contribution of different characters towards genetic divergence among 38 soybean genotypes.

Characters	Contribution towards divergence (%)
Days to 50% flowering	12.52
Days to maturity	20.63
Plant height (cm)	20.34
Number of branches per plant	0.14
Number of pods per plant	13.66
Pod length (cm)	0.00
Number of seeds per pod	0.28
100 seed weight (g)	1.71
Biological yield / plant (g)	0.71
Harvest index (%)	0.28
Protein content (%)	14.08
Oil content (%)	15.08
Seed yield / plant (g)	0.57

Table 6 : Eigen values per cent and cumulative variance in soybean for 5 PC's.

	PC1	PC2	PC3	PC4	PC5	PC6
Eigen value	3.35	2.59	1.77	1.51	1.07	0.67
% Variance explained	25.77	19.94	13.8	11.68	8.30	5.21
Cumulative variance explained	25.77	45.72	59.40	71.09	79.39	84.60

Principal factor scores (PF scores) for all the 38 genotypes were estimated in all the 5 PC's and utilized to construct precise 2D plot (Fig.2) and 3D plot (Fig.3). All the genotypes (name and number assigned are given in Table 1) were plotted for PC1, PC2, PC3, PC4 and PC5 which cumulatively explained 79.39% variability and accounted for all the characters (Fig.2 and 3).

The results of hierarchical cluster analysis and PCA confirmed the findings of each other. The plot of PC1, PC2, PC3, P4 and PC5 accounting for about 79.39% variation (Fig.2 and 3) showed clear differential of genotypes according to their cluster membership for each cluster. Genotypes belonging to a common cluster have fallen nearer to each other and vice-versa there by confirming the results of cluster analysis.

All the three methods of grouping revealed a single concept of non-correspondence of genetic divergence and geographic diversity. In a broad sense all the three methods of classifying genotypes into different groups are equally useful but hierarchical cluster analysis gave an additional advantage of identifying sub-clusters of the major groups at different levels so that each small group can be critically analysed.

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Combining Ability for Yield and Yield Component Traits in Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

In 8x8 diallel analysis combining ability and nature of gene action were studied for 19 characters viz., days to 50% flowering, plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, 100 seed cotton weight, number of seeds per boll, ginning out turn, seed index, lint index, 2.5% span length, micronaire value, bundle strength, uniformity ratio, fibre quality index, count strength product, lint yield per plant and seed cotton yield per plant. The parents HYPS-152, MCU-5 were the best general combiners for majority of the characters followed by CWROK-165, L.761. The crosses L-761 x NDLH-1678, L-761 x NDLH-1678 and MCU-5 x NA-1325 exhibited high sca effects for majority of the characters including seed cotton yield per plant. Non-additive gene effects were important for these traits.

Key words : Gossypium hirsutum L., Combining Ability, Gene Effects

Cotton (*Gossypium hirsutum* L.) is one of the important fibre crops playing a major role in the economic and social affairs of the world. The latest technological innovations coupled with global demand for quality cotton textile products offer a great opportunity for Indian cotton. Therefore, fibre quality parameters should be given due importance while planning for improvement of seed cotton yield. For a sound breeding programme, it is essential to identify potential parents and crosses for further genetic improvement. Combining ability studies aid in selection of suitable parents for uses in further improvement of yield along with fibre quality characters in cotton. Diallel analysis is one of the best important biometrical techniques, which provide valuable information about gene action through the estimates of general combining ability (gca) and specific combining ability (sca) variances and their effects. Thus, it helps in giving useful information regarding the selection of the parents in the performance of their hybrids.

MATERIAL AND METHODS

Eight parents and their F_1 progenies were grown in a randomized block design with three replications at Regional Agricultural Research Station, Lam, Guntur during 2005-2006. An inter- and intra- row spacing of 120 x 60 cm between plants was adopted. Data were recorded for 19 characters namely, days to 50% flowering, plant height (cm), number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight (g), 100 seed cotton weight (g), number of seeds per boll, ginning out turn (%), seed index (g), lint index (g), 2.5% span length (mm), micronaire value (10^{-6} g/in), bundle strength (g/tex), uniformity ratio, fibre quality index, count strength product, lint yield per plant (g) and seed cotton yield per plant (g). Statistical analysis was carried out by using Griffing's (1956) method-1, model-1 for economic characters. The fibre quality index (FQI) and count strength product (CSP) were calculated by using the following equations evolved by CIRCOT, Mumbai, for prediction of spinning potentials of a genotype (Iyer, 2002).

$$FQI = \frac{LT}{\sqrt{M}}$$

$$CSP = 1.74\ FQI + 1600$$

where, L = 2.5% span length in mm; T = bundle strength in g/tex and M = micronaire value.

RESULTS AND DISCUSSION

The analysis of variance for combining ability showed the significant mean squares for general combining ability (gca) and specific combining ability (sca) indicating that both additive and non-additive gene effects were important for the expression of the traits, *viz.*, 2.5% span length, fiber quality index and count strength product. Similar results were reported by Rao and Reddy (2001), Siva Prasad *et. al.* (2004) and Sundaravadivelu *et. al.* (2005). The ratio of general combining ability component of variance to specific combining ability component of variance revealed that non-additive gene action was predominant for the traits days to 50% flowering, plant height, number of monopodia per plant, number of sympodia per plant, number of bolls

Table 1 : ANOVA for combining ability for different characters in cotton

	df	Days to 50% flowering	Plant height (cm)	Mono-podia / plant	Sympodia / plant	Bolls / plant	Boll weight (g)	100 seed cotton weight (g)	No. seeds/ boll	Ginning out turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire value	Bundle strength (g tex)	Uniformity ratio	Fibre quality index	count strength product	Lint yield / plant (g)	Seed cotton yield / plant (g)
GCA	7	1.817*	88.356**	0.403**	9.644**	205.639**	0.446**	1.402*	21.817**	7.242**	1.997**	0.193*	14.831**	0.430**	1.182*	14.519**	5864.732**	17867.440**	48.424*	518.866**
SCA	28	3.383*	76.852**	0.199**	7.232**	87.907**	0.232**	1.986**	17.879**	9.289**	0.984**	0.535**	1.763**	0.088**	1.991**	7.481**	1042.429**	3183.967**	152.446**	775.747**
Reciprocal	28	3.208**	33.839**	0.162**	8.421**	114.335**	0.255**	1.706**	20.063**	5.989**	1.090**	0.299**	1.435**	0.132**	2.253**	4.951**	857.034**	2617.688**	130.218**	802.122**
Error	126	0.835	1.501	0.040	1.237	1.863	0.030	0.506	0.803	2.267	0.258	0.085	0.323	0.022	0.473	0.449	177.890	540.437	18.412	101.257
σ^2g		0.061	5.428	0.023	0.525	12.736	0.026	0.056	1.313	0.311	0.109	0.007	0.907	0.025	0.045	0.879	355.428	1082.938	1.876	26.101
σ^2s		2.547	75.351	0.159	5.996	86.044	0.202	1.480	17.076	7.022	0.726	0.450	1.441	0.066	1.518	7.031	864.539	2643.53	134.034	674.490
σ^2recipro-cal		1.186	16.169	0.061	3.592	56.236	0.113	0.600	9.630	1.861	0.416	0.107	0.556	0.055	0.890	2.251	339.572	1038.25	55.903	350.433
GCA/SCA ratio		0.024	0.072	0.142	0.088	0.148	0.129	0.038	0.077	0.044	0.150	0.015	0.629	0.385	0.030	0.125	0.411	0.41	0.014	0.039

*, ** : Significant at 5% and 1% level of probability.   df = Degrees of freedom

Table 2 : Estimation of general combining ability effects of parents for different characters in cotton.

Parents	Days to 50% flowering	Plant height (cm)	No. of Mono-podia / plant	No. of Sympodia / plant	No. of Bolls / plant	Boll weight (g)	100 seed cotton weight (g)	No. seeds/ boll	Ginning out turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire value	Bundle strength (g tex)	Uniformity ratio	Fibre quality index	Count strength product	Lint yield / plant (g)	Seed cotton yield / plant (g)
NA-1325	-0.302	-0.543	0.068	0.988**	6.669**	-0.078	-0.046	0.078	-0.211	0.063	-0.050	-0.696**	-0.083*	0.142	-0.045	-1.978	-3.700	1.469	5.093*
NDLH-1678	0.031	2.964**	0.093*	1.128**	1.055**	0.068	-0.266	-0.484*	-0.287	-0.363**	-0.142*	-0.052	-0.129	-0.327*	-0.017	-0.023	0.300	0.417	1.902
MCU-5	-0.198	2.137**	0.164**	-0.549*	2.489**	-0.093*	0.080	1.141**	0.940**	-0.050	0.184**	1.592**	-0.208**	0.170	-1.431**	27.404**	48.031**	-1.326	-6.771**
CWROK-165	0.365	1.399**	0.201**	-0.008	1.110**	-0.136**	-0.299	-1.297**	1.126**	-0.342**	0.051	-1.106**	0.226**	-0.344*	0.575**	-25.268**	-44.013**	-0.362	-5.256*
L-763	0.281	-2.602**	0.007	0.301	-2.982**	-0.255**	0.293	-0.901**	-0.756*	0.244*	0.003	-0.483**	0.160**	0.093	-0.322*	-10.890**	-18.956**	-1.439	-1.17
L-7765	-0.094	-2.717**	-0.174**	-0.287	-4.564**	0.078	-0.010	-1.297**	-0.379*	0.032	-0.065	-0.452**	0.108**	-0.047	0.996**	-11.737**	-20.693**	-2.197*	-5.267*
L-761	0.427*	-2.404**	-0.170**	-0.424	-1.669**	0.210**	0.529**	1.474**	-0.419	0.693**	0.112	-0.141	0.086*	-0.149	1.315**	-6.964*	-12.185*	0.277	1.918
HYPS-152	-0.510*	1.767**	-0.190**	-1.147**	-2.108**	0.205**	-0.281	1.286**	-0.013	-0.277*	-0.093	1.337**	-0.159**	0.463**	-1.071**	29.456**	51.216**	3.161*	9.550**
SE (g)	0.140	0.287	0.047	0.260	0.319	0.041	0.166	0.210	0.352	0.119	0.068	0.133	0.033	0.161	0.157	3.120	5.436	1.003	2.353

*, ** : Significant at 5% and 1% level of probability.   df = Degrees of freedom

Table 3 : Estimation of specific combining abililty effects of crosses for different characters in cotton.

Crosses	Days to 50% flowering	Plant height (cm)	No. of Mono-podia / plant	No. of Sympodia / plant	No. of Bolls / plant	Boll weight (g)	100 seed cotton weight (g)	No. seeds/ boll	Ginning out turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire value (10^{-6} g/in)	Bundle strength (g/tex)	Uniformity ratio	Fibre quality index	count strength product	Lint yield / plant (g)	Seed cotton yield / plant (g)
NA-1325/NDLH-1678	-0.760	-2.175**	0.213	2.552**	7.384**	-0.028	0.346	2.235**	1.852	0.269	0.376*	0.332	0.059	0.049	-2.389**	0.276	0.375	13.459**	29.976**
NA-1325/MCU-5	-0.198	-1.382	0.142	-0.105	-4.500	0.097	-0.133	-1.537**	0.552	-0.161	0.033	1.048**	-0.246**	0.077	-2.774**	27.856**	48.629**	-0.628	-3.087
NA-1325/CWROK-165	1.260*	-12.510**	0.655**	-0.946	15.975	-0.165	0.962*	0.380	-0.612	0.764*	0.249	0.249	0.156	-1.176**	0.287	17.236*	-29.811*	-6.309*	-14.389*
NA-1325/L-763	0.990	-2.443**	-0.001	1.079	2.821**	-0.409**	-1.081	-1.682**	1.356	-0.796*	-0.185	1.040**	-0.115	-0.129	-0.950*	12.629	22.232	1.266	-0.337
NA-1325/L765	-0.969	3.855**	-0.303*	0.083	-5.664**	0.793**	0.268	-1.620**	-1.024	0.402	-0.040	0.305	-0.002	-1.239**	0.807	-12.904	-23.948	3.501	14.743*
NA-1325/L-761	-1.490**	7.543**	-0.157	-1.146	-8.617**	0.088	1.034*	3.443**	1.421	0.162	0.139	0.178	-0.085	0.179	-1.003*	7.557	13.411	-9.891**	-21.728**
NA-1325/HYPS-152	0.448	-3.778**	-0.020	0.0910	2.880**	-0.257**	0.195	2.464**	1.801	0.001	0.344	-0.097	-0.143	0.501	-1.434**	11.003	19.404	7.673**	11.580
NDLH-1678/NA-1325	-1.000	-3.750**	-0.100	-1.083	-1.233	0.078	0.850	-0.667	-3.165**	1.000**	-0.150	0.397	0.033	0.525	1.617**	10.557	18.333	-1.945	7.760
NDLH-1678/MCU-5	0.469	-4.205**	0.166	-0.628	9.947**	-0.034	-1.51**	-0.828	0.604	-0.484	-0.358*	0.042	-0.246**	0.746	0.714	24.835**	45.361**	-2.844	-8.878
NDLH-1678/CWROK-165	-1.594*	5.733**	0.179	1.747*	-7.107**	0.289**	-0.034	1.609**	2.382*	-0.826**	0.341	-0.828*	0.057	0.876*	0.975*	-0.536	-1.395	-0.491	-8.055
NDLH-1678/L-763	-0.510	-5.349**	0.190	-2.844**	-5.131**	0.652**	-0.109	0.047	1.842	0.555	0.223	-1.509**	0.004	-0.027	3.447**	-17.239*	-30.269*	-0.322	-6.010
NDLH-1678/L765	0.365	-1.951*	-0.112	0.760	0.367	-0.201	1.760**	5.934**	0.256**	1.467**	0.691**	1.113**	0.046	0.096	-1.453**	11.991	20.768	-3.660	-9.826
NDLH-1678/L-761	0.344	5.270**	0.284*	-0.386	-0.903	-0.151	-0.402	-4.161**	2.140*	-0.036	0.214	-0.248	-0.289**	-0.752	0.085	2.163	3.443	10.592**	18.241**
NDLH-1678/HYPS-152	-0.219	0.132	-0.313*	0.437	3.621**	0.164	-0.227	-2.307**	-2.576**	0.026	-0.465*	0.644	0.088	-0.331	-1.779**	-4.068	-7.258	-2.820	1.759
MCU-5/NA-1325	-1.333*	-1.217	0.200	0.150	6.100**	0.245*	-0.617	1.167	-0.838	-0.250	-0.367	1.470**	-0.223*	-0.400	1.217*	24.117**	41.683*	12.118**	34.087**
MCU-5/NDLH-1678	-1.333*	8.800**	0.350*	2.267**	5.250**	-0.030	0.455	-1.000	0.845	0.167	0.300	-0.435	-0.082	-0.800	-0.100	-12.083	-23.917	-0.113	-3.235
MCU-5/CWROK-165	-0.365	3.926**	0.408**	0.924	-0.541	0.119	0.137	-2.682**	0.213	0.111	0.082	-0.595	0.017	0.329	-0.769	-1.724	-3.334	1.556	3.913
MCU-5/L-763	-0.448	8.177*	-0.331**	-0.401	1.368	-0.068	0.696	2.755**	1.206	0.275	0.397*	-0.890*	-0.038	-0.941	1.753**	-21.519**	-37.81**	7.290**	12.937*
MCU-5/L765	-1.573*	-3.525**	0.267*	2.920**	4.899**	0.219*	-0.002	-1.182*	0.022	-0.580	-0.018	-1.519**	-0.113	-0.550	0.935*	-34.135**	-59.545*	5.706*	16.190*
MCU-5/L-761	0.073	-8.337**	0.063	3.258**	5.538**	-0.533**	1.009*	1.214*	0.455	0.559	0.505**	-0.375	0.169	1.226**	-1.567**	6.092	10.196	-1.056	-4.446
MCU-5/HYPS-152	-0.323	-4.675**	-0.096	-0.453	-6.290**	0.004	1.453*	1.734**	0.285	0.996**	0.610**	0.699	0.375**	-2.086**	0.610	-40.795**	-71.305**	-6.743*	-19.202**
CWROK-165/NA-1325	0.833	4.950**	0.150	0.917	14.450**	-0.120	-0.600	-1.333*	-0.773	-0.317	-0.283	0.050	0.490**	0.300	-2.217**	-12.147	-21.033	4.435	14.230*
CWROK-165/NDLH-1678	0.500	2.800**	-0.100	1.783*	-5.117**	-0.157	-0.217	0.828	-1.225	-0.733**	-0.283	0.480	0.095	-0.783	0.967*	-8.742	-15.350	-1.632	-0.937
CWROK-165MCU-5	-0.167	4.367**	0.200	-0.483	9.817**	0.088	-1.233	1.333*	1.477	-0.983**	-0.250	-0.543	0.353**	0.033	0.108	-18.653	-32.475	10.552**	22.295**
CWROK-165/L-763	-0.844	10.683**	0.015	2.824**	5.188**	0.170	1.441**	-1.141*	-0.094	0.934**	0.547**	1.180**	0.180	1.48**	-3.670**	26.706**	46.528**	1.079	3.404
CWROK-165/L765	1.698*	-4.953**	-0.303*	-0.155	3.545**	-0.396**	-0.923*	-2.578**	3.523**	-0.955**	0.165	0.600	0.050	1.235**	-0.971*	23.002**	40.349**	21.243**	40.747**
CWROK-165/L-761	0.344	-4.965**	0.026	0.616	-3.008**	0.052	0.704	-1.682**	-2.503**	0.676*	-0.116	0.386	0.244**	-1.118**	1.227**	-20.605*	-35.810*	-3.869	-3.041
CWROK-165/HYPS-152	-0.552	3.197**	-0.204	-1.078	-7.678**	-0.205	-0.652	5.672**	2.786**	-0.557	0.0117	-0.7[illegible]7*	-0.114	-0.237	1.471**	-8.674	-15.061	-5.399*	-21.169**
L-763/NA-1325	-2.333**	4.983**	0.100	2.917**	3.567**	-0.062	-2.015**	0.667	-1.850	-0.975**	-1.033**	-0.367	-0.152	-1.750**	0.650	-22.870*	-39.768	10.663**	34.215**
L-763/NDLH-1678	-0.167	0.383	0.517**	-0.967	-6.400**	0.485**	-0.700	3.500**	1.667	-0.200	-0.017	-0.748	-0.235*	0.350	0.775	4.883	8.600	-1.810	-9.838

contd.,

Table 3 : Estimation of specific combining abililty effects of crosses for different characters in cotton (contd.,)

Crosses	Days to 50% flowering	Plant height (cm)	No. of Mono-podia / plant	No. of Sympodia / plant	No. of Bolls / plant	Boll weight (g)	100 seed cotton weight (g)	No. seeds/ boll	Ginning out turn (%)	Seed index (g)	Lint index (g)	2.5% span length (mm)	Micronaire value (10^{-6} g/in)	Bundle strength (g/tex)	Uniformity ratio	Fibre quality index	count strength product	Lint yield / plant (g)	Seed cotton yield / plant (g)
L-763/MCU-5	0.667	1.117	0.067	0.433	7.733**	-0.083	-2.017**	-4.833**	2.168*	-1.633**	-0.417*	-1.708**	0.115	-0.033	0.567	-23.470*	-40.917*	20.192**	44.548**
L-763/CWROK-165	-0.833	5.683**	-0.050	3.267**	1.425	-0.188	1.617**	1.167	0.597	0.800**	0.700**	0.767	0.223*	2.740**	-0.283	37.317**	64.883**	7.248**	17.660*
L-763 / L-765	-0.219	-4.452**	0.091	-0.780	-2.596**	-0.449**	0.718	3.693**	0.057	0.726*	0.263	-0.229	0.370**	-1.281**	1.226**	-28.942**	-50.076**	-7.941**	-21.770**
L-763 / L-761	-1.073	-5.898**	-0.313*	-1.692*	-2.291**	0.282**	-0.588	-2.411**	-0.291	-0.435	-0.264	-0.438	-0.276**	0.845	-1.443**	15.422	26.868	-3.752	-9.197
L-763 / HYPS-152	0.698	-1.952*	0.290*	1.397*	2.031*	-0.208	0.890*	-0.891	-1.176	0.561	0.158	0.614	-0.061	-0.184	0.926*	4.599	8.015	10.968**	35.530**
L-765 / NA-1325	0.333	2.600**	0.483**	0.300	4.133**	-0.368**	-0.838	1.667**	-0.990	-0.405	-0.443*	-0.250	0.147	-1.567**	2.375**	-30.050**	-54.250**	5.820	20.308**
L-765 / NDLH-1678	-1.000	2.700**	0.367**	1.750*	6.650**	-0.095	-0.367	-4.333**	0.637	-0.350	-0.017	-0.475	-0.185	1.267**	0.440	21.067*	36.633*	1.313	1.688
L-765 / MCU-5	0.833	-6.400**	0.117	2.800**	2.983**	-0.043	-0.117	3.167**	0.660	0.500	0.067	-1.223**	-0.095	-0.667	0.100	-2.433	-4.183	8.917**	21.395**
L-765 / CWROK-165	-0.333	5.367**	-0.317*	3.933**	12.350**	0.338**	0.217	-0.333	2.617*	-0.233	0.450*	-0.188	0.155	-0.988*	1.133*	-20.733*	-36.033*	15.082**	26.353**
L-765 / L-763	0.667	-1.333	0.150	3.317**	1.817	0.297*	-0.217	-7.333**	-0.220	-0.033	-0.100	-0.808	-0.342**	0.925	0.467	14.167	24.700	-1.690	-4.368
L-765 / L-761	1.302*	-2.317**	-0.132	-1.955**	1.838*	0.294**	0.268	0.984	0.331	-0.360	-0.029	-0.171	0.016	-0.418	0.556	-5.512	-9.280	-6.420*	-17.547**
L-765 / HYPS-152	-2.427*	-2.454**	0.271*	-2.798**	1.279	0.059	-0.458	-3.661**	1.144	-0.803*	-0.024	-1.249**	-0.044	1.090*	-2.042**	3.429	6.169	-2.574	-9.102
L-761 / NA-1325	-1.333*	-4.000**	0.333*	0.067	11.342**	-0.030	-1.100*	-4.833**	1.567	-0.450	-0.133	-1.077**	-0.505**	-0.750	0.367	-2.450	-4.250	-3.872	-15.965*
L-761 / NDLH-1678	-2.833**	-0.733	-0.433**	3.100**	11.592**	-0.217	-0.023	1.667**	2.662*	-0.908**	0.383	-0.288	-0.635**	1.617**	2.400**	49.090**	85.417**	17.133**	33.767**
L-761 / MCU-5	-0.667	7.767**	-0.050	3.300**	11.183**	0.370**	-0.333	-5.333**	0.597	-0.600	0.372	0.032	-0.068	-0.292	2.917**	-1.200	-2.033	8.072**	18.510**
L-761/ CWROK-165	-1.500*	5.267**	0.317*	2.600**	10.958**	0.145	-0.717	2.667**	3.108**	-0.975**	0.253	0.505	-0.230*	-0.600	0.950*	2.035	3.483	9.940**	17.283*
L-761 / L-763	0.333	-4.333**	-0.350*	0.333	-1.538	-0.243*	0.638	3.000**	-1.862	0.733*	-0.050	2.287**	-0.220*	-1.733**	-2.383**	10.597	18.452	-4.697	-6.843
L-761 / L-765	-1.333*	5.773**	-0.117	0.583	-2.388	0.578**	0.900	-7.667**	-0.360	0.633	0.283	0.522	0.023	-0.837	2.233**	-19.655*	-34.200*	-4.327	-10.893
L-761 / HYPS-152	-0.615	4.533**	-0.283*	0.072	10.068**	0.574**	0.368	4.401**	1.009	0.019	0.307	-0.784*	0.221*	-0.750	0.640	-30.780**	-53.573**	17.149**	42.124**
HYPS-152 / NA-1325	0.421	0.850	0.317*	3.533**	7.567**	0.120	-0.117	-0.667	-1.612	0.150	-0.267	0.637	-0.022	-1.650**	1.183*	-16.917	-29.455	1.297	9.872
HYPS-152 / NDLH-1678	1.667**	-0.033	0.083	2.567**	10.807**	-0.423**	0.408	2.667**	-0.542	1.000**	0.067	0.195	-0.070	-0.017	-0.300	4.533	7.850	-0.258	1.570
HYPS-152 / MCU-5	1.667**	3.933**	0.472**	0.433	0.150	-0.135	0.300	-2.333**	1.107	0.033	0.267	0.010	-0.428**	0.308	-0.325	22.967*	39.933*	-2.608	-9.488
HYPS-152 / CWROK-165	-1.000	2.933**	0.167	-0.083	-4.283	0.437**	0.350	-2.167**	-1.577	0.105	-0.092	-1.050**	0.273*	-1.040*	3.092**	-37.783**	-65.733**	6.067*	18.897**
HYPS-152 / L-763	1.500*	-0.417	0.567**	-0.267	1.000	-0.642**	1.850**	-3.000**	2.150	0.742*	1.000**	-1.277**	0.057	-0.050	1.700**	-17.633	-30.667	-5.440	-25.778**
HYPS-152 / L-765	-1.333*	-2.000	0.107	-0.817	-9.867**	-0.095	-0.467	0.550	3.243**	-1.350**	0.283	-0.402	0.082	0.483	-0.083	-2.350	-4.117	-5.000	-23.520**
HYPS-152 / L-761	-2.330**	-0.133	-0.117	-1.350	-7.383	1.185**	-1.150	0.891	1.805	-1.000**	-0.158	0.200	-0.192	1.125*	-3.250**	24.813**	43.317**	-1.693	-13.400
SE (S_g)	0.571	0.766	0.125	0.695	1.194	0.108	0.445	0.560	0.941	0.317	0.182	0.355	0.094	0.430	0.420	8.335	14.530	2.681	6.290
(r_g)	0.646	0.866	0.142	0.786	0.965	0.123	0.503	0.634	1.064	0.359	0.206	0.401	0.106	0.486	0.474	9.431	16.438	3.034	7.115

*, ** Significant at 5% and 1% level of probability, respectively.

per plant, boll weight, 100 seed cotton weight, number of seeds per boll, ginning out turn, seed index, lint index, micronaire value, bundle strength, uniformity ratio, lint yield per plant and seed cotton yield per plant (Table 1). These findings are in agreement with Neelima (2002), Laxman and Ganesh (2003), Mert *et. al.* (2003), Siva Prasad *et. al.* (2004) and Sundaravadivelu *et. al.* (2005).

HYPS-152 was a good general combiner for days to 50% flowering, plant height, boll weight, number of seeds per boll, 2.5% span length, bundle strength, fiber quality index and count strength product, lint yield per plant and seed cotton yield per plant, whereas the parent MCU-5 showed significant gca effects for plant height, number of monopodia per plant, number of bolls per plant, number of seeds per boll, ginning out turn, lint index, 2.5% span length, fiber quality index, count strength product. The parents HYPS-152 and NA-1325 showed significant gca effects for seed cotton yield per plant (Table 2).

The specific combining ability effects were estimated for all 56 hybrids for all the 19 characters. The estimates of sca effects showed that 21 out of 56 hybrids had high sca effects for seed cotton yield per plant. Among the cross combinations L-761 x CWROK-165 (high x high), L-761 x NDLH-1678 (high x low), MCU-5 x NA-1325 (high x low), L-763 x CWROK-165 (low x high) and L-765 x CWROK-165 (low x high) showed high sca effects for majority of the traits, combining seed cotton yield per plant, respectively. L-761 x CWROK-165 showed significant sca effects for days to 50% flowering, plant height, number of monopodia per plant, number of sympodia per plant, number of bolls per plant, number of seeds per boll, ginning out turn, uniformity ratio, lint yield per plant and seed cotton yield per plant (Table 3).

The cross combinations involving high x high general combiners may be advanced using pedigree method of breeding for improving yield *per se*, since these involve additive and additive x additive interactions. While, the cross combinations involving high x low or low x high general combiners with significant sca effects are likely to produce desirable transgressive segregants which may be studied through biparental mating or diallel selective mating or any other form of recurrent selection in the early generations followed by single plant selections to exploit both additive and non-additive gene actions.

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Character Association, Path Analysis and Selection Indices in Roselle (*Hibiscus sabdariffa* L.)

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ABSTRACT

Correlation and path analyses of fifty genotypes of roselle indicated that basal stem diameter, bark thickness, fibre length and fibre yield/ plant were significantly and positively associated with fibre yield / plot. Discriminant function identified combination of seven characters *viz.*, plant height, number of internodes, basal stem diameter, bark thickness, fibre length, fibre yield / plant and fibre yield / plot for highest genetic advance and relative efficiency, suggesting that these are the important traits for constructing selection indices in roselle.

Key words : Correlation, Path Analysis, Selection Indices, Roselle

Roselle is one of the important fibre yielding crops. But the production and productivity of fibre are low. Therefore, present investigation is carried out for correlation and path analyses along with the development of selection indices to discriminate desirable genotypes from undesirable ones on the basis of their phenotypic performance.

MATERIAL AND METHODS

The experiment was conducted at Agricultural College Farm, Bapatla during *kharif* 2005 in randomized complete block design with four replications. Each genotype was sown in three rows with a length of 4 m and inter-and intra-row spacing of 30 x 10 cm in black clay soil. Five plants from the middle one row leaving the border plants, in each genotype per replication were chosen at random. The crop was harvested at 50% flowering stage and fibre was extracted by the standard process of retting. The observations were recorded on days to 50% flowering, plant height (cm), number of internodes, internodal length (cm), basal stem diameter (cm), bark thickness (cm), fibre – wood ratio, fibre length (cm), fibre yield/plant (g) and fibre yield / plot (g).

The phenotypic and genotypic correlations were worked as suggested by Falconer (1964) and path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

As per discriminant function analysis by Fisher (1936) and Smith (1936), selection indices were constructed for all possible combinations of yield contributing characters. Relative efficiencies over selection for fibre yield/plot alone were computed for all ten characters.

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences among the genotypes for all characters. All the traits showed the higher magnitude of genotypic correlations than phenotypic correlations (Table 1) indicating that there was a strong inherent association between characters, which was truly reflected in phenotypic expression.

The character fibre yield / plot showed significant positive association with plant height, number of internodes, basal stem diameter, bark thickness, fibre length and fibre yield / plant. These results are in agreement with Aruna *et. al.* (1988) and Adilakshmi (1992). Internodal length and fibre-wood ratio showed significantly negative association with fibre yield / plot (Table 1).

In path analysis plant height, basal stem diameter and fibre yield per plant showed the positive direct effects at the genotypic level. While days to 50% flowering, plant height, number of internodes and internodal length bark thickness, fibre-wood ratio and fibre length exhibited negative direct effect on fibre yield / plot at genotypic level (Table 2).

While constructing discriminant function, inclusion of characters one by one in the function resulted in the increased efficiency of selection (Table 3). The character bark thickness showed highest genetic advance and relative efficiency when the individual characters are taken but in two character combination highest genetic advance (1.27) was observed with the characters basal stem diameter and bark thickness. In three character combination highest genetic advance (1.75) was observed with the characters fibre yield

Table 1: Phenotypic, genotypic correlation coefficients of yield components in 50 genotypes of roselle hemp (*Habiscus sabdariffa* L.).

Character		Days to 50% flowering	Plant height	No. of internodes	Internodal length	Basal stem diameter	Bark thickness	Fibre wood ratio	Fibre length	Fibre yield / plant
Days to 50% flowering	P	0.0356	0.0307	-0.0538	-0.0791	-0.0588	-0.0499	0.0367	0.1092	0.0955
	G	0.0414	0.0303	-0.0503	-0.0847	-0.0605	-0.0504	0.0431	0.1099	0.0995
Plant height	P		0.7973**	-0.6613**	0.8058**	0.6040**	-0.3932**	0.9914**	0.7468**	0.7359**
	G		0.8221**	-0.7197**	0.8428**	0.6212**	-0.4075**	0.9999**	0.7641**	0.7602**
Number of internodes	P			-0.5866**	0.6672**	0.5057**	-0.1852*	0.8096**	0.8319**	0.6787**
	G			-0.6195**	0.6872**	-0.3675**	-0.1872*	0.8360**	0.8408**	0.6988**
Internodal length	P				-0.4996**	-0.3885**	0.3428**	-0.6677**	-0.5336**	-0.5644**
	G				-0.5418**	0.7262**	0.3613**	-0.7347**	-0.5637**	-0.6056**
Basal stem diameter	P					0.7479**	-0.2856**	0.7993**	0.6066**	0.5968**
	G						-0.2920**	0.8435**	0.6206**	0.6523**
Bark thickness	P						-0.0194	0.6012**	0.5072**	0.5006**
	G						-0.0206	0.6264**	0.5129**	0.5140**
Fibre wood ratio	P							-0.3639**	-0.1834**	-0.2781**
	G							-0.3799**	-0.1846*	-0.2861**
Fibre length	P								0.7538**	0.7389**
	G								0.7766**	0.7691**
Fibre yield / plant	P									0.9353**
	G									0.9529**

** Significant at 1% level, * Significant at 5% level, P = Phenotypic correlation coefficient, G = Genotypic correlation coefficient

per plot, bark thickness and fibre yield per plant. In four character combination highest genetic advance (2.14) was seen with fibre yield per plot, basal stem diameter, bark thickness and fibre yield per plant. Five parameter combination, fibre yield per plot, basal stem diameter, bark thickness, fibre length and fibre yield per plant showed highest genetic advance (2.41). In six and seven parameter combinations, genetic advance was 2.67 where the character, days to 50% flowering, contributed nil to the genetic advance and the remaining characters were fibre yield per plot, bark thickness, basal stem diameter, plant height, fibre length and fibre yield per plant.

The character, fibre yield per plant showed a genetic advance of 2.84 with the characters *viz.*, plant height, number of internodes, basal stem diameter, bark thickness, fibre length, fibre yield/ plot with a relative efficiency of 502.90%. But high genetic advance of 2.85 was exhibited with the 8 characters viz., days to 50% flowering, plant height, number of internodes, basal stem diameter, bark thickness, fibre length, fibre yield / plant and fibre yield/plot with a relative efficiency

Table 2: Phenotypic, genotypic pathc coefficients of yield components in 50 genotypes of roselle (Hibiscus sabdariffa L.).

Character		Days to 50% flowering	Plant height	No. of internodes	Internodal length	Basal stem diameter	Bark thickness	Fibre wood ratio	Fibre length	Fibre yield / plant
Days to 50% flowering	P	**-0.0252**	-0.0009	-0.0008	0.0014	0.0020	0.0015	0.0013	-0.0009	-0.0028
	G	**-0.0225**	-0.0009	-0.0007	0.0011	0.0019	0.0014	0.0011	-0.0010	-0.0025
Plant height	P	-0.0024	**-0.0681**	-0.0543	0.0450	-0.0548	-0.0411	0.0268	-0.0675	-0.0508
	G	0.0367	**0.8863**	0.7286	-0.6379	0.7469	0.5505	-0.3611	0.8862	0.6772
Number of internodes	P	-0.0153	-0.3962	**-0.4969**	0.2915	-0.3315	-0.2459	0.0920	-0.4023	-0.4134
	G	-0.0158	-0.4284	**-0.5212**	0.3228	-0.3581	-0.2635	0.0976	-0.4357	-0.4380
Internodal length	P	0.0054	0.0659	0.0585	**-0.0997**	0.0498	0.0366	-0.0342	0.0666	0.0532
	G	0.0074	0.1059	0.0912	**-0.1472**	0.0797	0.0572	-0.0532	0.1081	0.0830
Basal stem diameter	P	-0.0025	0.0253	0.0210	-0.0157	**0.0314**	0.0228	-0.0090	0.0251	0.0191
	G	-0.0060	0.0594	0.0484	-0.0382	**0.0705**	0.0527	-0.0206	0.0595	0.0437
Bark thickness	P	-0.0005	0.0050	0.0041	-0.0030	0.0060	**0.0083**	-0.0002	0.0050	0.0042
	G	0.0005	-0.0056	-0.0046	0.0035	-0.0068	**-0.0091**	0.0002	-0.0057	-0.0047
Fibre wood ratio	P	0.0031	0.0243	0.0114	-0.0212	0.0176	0.0012	**-0.0618**	0.0225	0.0133
	G	0.0013	0.0105	0.0048	-0.0093	0.0075	0.0005	**-0.0259**	0.0098	0.0048
Fibre length	P	0.0085	0.2286	0.1867	-0.1540	0.1843	0.1386	-0.0839	**0.2306**	0.1738
	G	-0.0336	-0.7804	-0.6524	0.5734	-0.6583	-0.4889	0.2965	**-0.7805**	-0.6061
Fibre yield / plant	P	0.1245	0.8519	0.9490	-0.6087	0.6920	0.5786	-0.2092	0.8598	**1.1407**
	G	0.1314	0.9134	1.0046	-0.6739	0.7419	0.6132	-0.2207	0.9283	**1.1954**
Fibre yield / plant [r(p)]		0.0955	0.7359**	0.6787**	-0.5644**	0.5968**	0.5006**	-0.2781**	0.7389**	0.9353**
Fibre yield / plant [r(g)]		0.0995	0.7602**	0.6988**	-0.6056**	0.6253**	0.5140**	-0.2861**	0.7691**	0.9529**

Values in bold are diect effects, ** Significant at 1% level, [r(p)] = Phenotypic correlation coefficient, [r(g)] = Genotypic correlation coefficient, P = Phenotypic path coefficient, G = Genotypic path coefficient

Table 3: Selection indices for different character combination in rosella (*Hibiscus sabdariffa* L.)

Character combination	Genetic advance	Relative efficacy (%)
Fibre yield per plot (X_1)	0.57	100.00
Days to 50% flowering (X_2)	0.17	26.25
Plant height (X_3)	0:28	49.61
No. of internodes ((X_4)	0:20	35.07
Internodal length (X_5)	0.30	52.20
Basal stem diameter (X_6)	0:46	82.07
Bark thickness (X_7)	0.88	155.22
Fibre-wood ratio (X_8)	0.53	93.24
fibre length (X_9)	0.30	53.47
fibre yield per plant (X_{10})	0.56	99.30
$x_1 + x_8$	0.93	165.21
$x_1 + x_7$	1.27	224.09
$x_6 + x_7$	1.27	224.55
$x_1 + x_2 + x_7$	1.26	226.15
$x_1 + x_3 + x_7$	1.50	265.02
$x_1 + x_6 + x_7$	1.67	295.15
$x_1 + x_7 + x_{10}$	1.75	310.04
$x_1 + x_2 + x_7 + x_{10}$	1.77	312.50
$x_1 + x_3 + x_6 + x_7$	1.90	338.08
$x_1 + x_3 + x_7 + x_{10}$	1.99	351.89
$x_1 + x_6 + x_7 + x_{10}$	2.14	378.85
$x_1 + x_2 + x_6 + x_7 + x_{10}$	2.15	380.30
$x_1 + x_3 + x_4 + x_7 + x_{10}$	2.16	382.02
$x_1 + x_3 + x_6 + x_7 + x_9$	2.19	386.02
$x_1 + x_3 + x_6 + x_7 + x_{10}$	2.39	422.38
$x_1 + x_6 + x_7 + x_9 + x_{10}$	2.41	426.53
$x_1 + x_2 + x_6 + x_7 + x_9 + x_{10}$	2.42	428:00
$x_1 + x_3 + x_4 + x_6 + x_7 + x_{10}$	2.56	453.2[illegible]
$x_1 + x_3 + x_6 + x_7 + x_9 + x_{10}$	2.67	471.34
$x_1 + x_2 + x_3 + x_6 + x_7 + x_9 + x_{10}$	2.67	472.81
$x_1 + x_3 + x_4 + x_6 + x_7 + x_9 + x_{10}$	2.84	502.90
$x_1 + x_2 + x_3 + x_4 + x_6 + x_7 + x_9 + x_{10}$	2.85	504.25

of 504.25% (Table 3). The character, days to 50% flowering, added very little *i.e.*, 0.01 genetic advance to the seven character index, so it is worth while to select the seven parameter index in the selection process. These results are in agreement with Aruna *et. al.* (1988).

In the comparison, path analysis fund that the characters basal stem diameter, bark thickness, fibre length and fibre yield / plant had a direct effect on fibre yield / plot whereas the selection indices revealed that the combination of 7 characters viz., plant height, number of internodes, basal stem diameter, bark thickness, fibre length, fibre yield / plant and fibre yield / plot are important for simultaneous improvement of the characters.

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Journal
Since 1954

Multivariate Analysis in Greengram [*Vigna radiata* (L.)Wilczek]

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ABSTRACT

Forty genotypes of greengram were evaluated for genetic diversity using Mahalanobis' D^2 statistics and were grouped into six clusters. The number of primary branches per plant contributed maximum towards genetic divergence followed by protein content and days to 50% flowering. Hierarchical cluster analysis grouped the genotypes into seven clusters. The best clusters with regard to seed yield and protein content were cluster IV and VI. Principal factor analysis identified three principal components which explained 79.19% variability in greengram.

Key words : Greengram, D^2 Analysis, Cluster Analysis and Principal Component Analysis

In self-pollinated crops like greengram, development of hybrid varieties is not successful due to crossing barrier. However, it is important to select divergent parent with stable performance for yield as well as other yield attributing characters for hybridization and to obtain favourable recombinants through selection in the advanced breeding generations. Hence, the present study was undertaken to assess the nature and the magnitude of genetic diversity and also to identify suitable donors having wider genetic base in greengram.

MATERIAL AND METHODS

Forty diverse greengram genotypes were raised in randomized block design replicated with three replications during *rabi* 2005-06 at Regional Agricultural Research Station (RARS), Lam, Guntur (Table 1). Each genotype was raised in four rows of 4 m length adopting an inter- and intra- row spacing of 30 x 10 cm. The biometrical observations were recorded on ten plants selected at random from the middle for the rows per replication for *viz.,* plant height, number of primary branches per plant, number of clusters per plant, number of pods per cluster, pod length, number of seeds per pod, seed yield per plant. Data on days to 50% flowering, days to maturity, 100 seed weight and protein content were recorded on plot basis. The data were subjected to D^2 analysis (Mahalanobis, 1928), hierarchical cluster analysis (Anderberg, 1993) and principal component analysis (Jackson, 1991) using SPSS computer programme. The PC's with eigen value > 1 were retained and < 1 were considered as non-significant (Legendre and Legendre, 1984).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant difference among the genotypes for eleven characters. This difference indicated the existence of significant amount of variability among the genotypes for the characters studied. On the basis of D^2 analysis and cluster analysis, the 40 genotypes were grouped into six and seven clusters, respectively (Table 2 and Fig.1).

The variation in the composition of individual cluster with regard to the number of genotypes indicated the presence of large amount of diversity in the population. On the basis of D^2 analysis and cluster analysis pattern of distribution of genotypes from different eco-geographical regions into various clusters was at random indicating that geographical diversity and genetic diversity were not related.

On the basis of D^2 analysis the minimum intra- cluster distance was observed in cluster I (93.52) and the maximum in cluster II (110.85) (Table 3). The intra- cluster distance values were zero in the clusters which had one genotype. While minimum intra- cluster distance was observed in cluster I (103.33) and maximum in cluster VII (34.28) in the case of cluster analysis (Table 4). The intra- cluster distance values were zero incase of cluster IV, which has single genotype.

Similarly the least inter- cluster distance was observed between I and IV (134.71), while, the highest between III and VI (1270.98) on the basis D^2 analysis while, it was maximum between VII and IV (1427.56) on the basis of cluster analysis.

Table 1: Source of origin of 40 greengram genotypes under study.

S.No.	Genotypes	Source
1	LGG-410	Lam, Guntur
2	LGG-407	Lam, Guntur
3	LGG-450	Lam, Guntur
4	LGG-460	Lam, Guntur
5	TM-96-2	Trombay
6	LGG-483	Lam, Guntur
7	LGG-486	Lam, Guntur
8	LGG-480	Lam, Guntur
9	LGG-485	Lam, Guntur
10	LGG-505	Lam, Guntur
11	LGG-525	Lam, Guntur
12	LGG-526	Lam, Guntur
13	LGG-527	Lam, Guntur
14	LGG-491	Lam, Guntur
15	LGG-502	Lam, Guntur
16	LGG-498	Lam, Guntur
17	LGG-497	Lam, Guntur
18	LGG-496	Lam, Guntur
19	LGG-492	Lam, Guntur
20	LGG-488	Lam, Guntur
21	WGG-2	Lam, Guntur
22	MGG-295	Lam, Guntur
23	OYT-2	Lam, Guntur
24	OYT-4	Lam, Guntur
25	OYT-6	Lam, Guntur
26	OYT-11	Warangal
27	OYT-13	Madhira
28	OYT-16	Lam, Guntur
29	OYT-26	Lam, Guntur
30	OYT-21	Lam, Guntur
31	OYT-23	Lam, Guntur
32	OYT-18	Lam, Guntur
33	LGG-529	Lam, Guntur
34	LGG-521	Lam, Guntur
35	LGG-522	Lam, Guntur
36	LGG-530	Lam, Guntur
37	LGG-531	Lam, Guntur
38	LGG-533	Lam, Guntur
39	LGG-532	Lam, Guntur
40	LAM-M2	Lam, Guntur

The hybridization between genotypes from the clusters with maximum inter- cluster distances should give rise to heterotic hybrids in F_1 and desirable transgressive segregants in subsequent segregating generations.

The additional advantage of D^2 analysis is estimation of the contribution of various characters towards the expression of the genetic divergence. This analysis indicated that the number of primary branches per plant (32.05), protein content (28.08) and days to 50% flowering (18.85) along with days to maturity and 100 seed weight accounted for more than 90 per cent of total divergence in the material (Table 5). These results are on par with those of Nareshchandra and Chaturvedi (1993) and Manivannan *et. al.* (1998) in greengram. While the additional advantage in hierarchical cluster analysis is identifying sub-cluster of the major groups at different levels so that each small group can be critically analysed.

Table 2: Distribution of 40 genotypes of greengram in different clusters based on D^2 analysis.

Cluster	No. of genotyes	Name of genotyes
I	20	OYT-16, OYT-21, OYT-26, LGG-532, OYT-6, OYT-4, LGG-531, LGG-498, LGG-492, LGG-530, LGG-496, LGG-533, OYT-11, OYT-2, LGG-491, LGG-525, LGG-483, LGG-485, OYT-13, LGG-488.
II	12	TM-96-2, MGG-295, LGG-450, LGG-410, LGG-460, LGG-502, LGG-486, LGG-505, LGG-407, LGG-527, LGG-497, WGG-2
III	5	OYT-18, LGG-521, LGG-522, LGG-526, OYT-23.
IV	1	LGG-529
V	1	LGG-480
VI	1	LAM-M2

Table 3 : Intra- and inter- cluster distance values of six clusters (based on D^2 analysis) estimated for 40 genotypes of greengram.

Cluster	I	II	III	IV	V	VI
I	**93.52**	184.56	178.18	1[illegible]4.71	390.50	1172.27
II		**110.85**	330.57	168.03	163.86	997.56
III			**109.78**	241.83	571.07	1270.98
IV				**0.00**	296.40	1107.90
V					**0.00**	884.27
VI						**0.00**

Bold and diagonal values indicate intra-cluster distance.

In the principal component (PC) method first three principal components showed eigen values more than one and they altogether explained 79.19% of the variability (Table 6). The first PC explained 46.18 percentage of the total variability in the set of all variables and remaining ones accounted for progressively lesser and lesser amount of variation.

Principal factor scores (PF scores) for all the 40 genotypes were estimated in all the three PC's and utilized to construct precise 2D plot (Fig.2) and 3D plot (Fig.3). All the genotypes were plotted for PC_1, PC_2 and PC^3 which cumulatively explained 79.19% of variability which accounted for all the characters. Characters like plant height, number of clusters per plant, protein content and seed yield per plant were loaded with positive correlation in first principal component and explained maximum variance in PCA.

All the three methods of grouping revealed a single concept of non-correspondence of genetic divergence and geographic diversities. All the three methods of classifying genotypes into different groups is equally useful but hierarchical cluster analysis gave an additional advantage of identifying sub-cluster of the major groups at different levels so that each small group can be critically analysed.

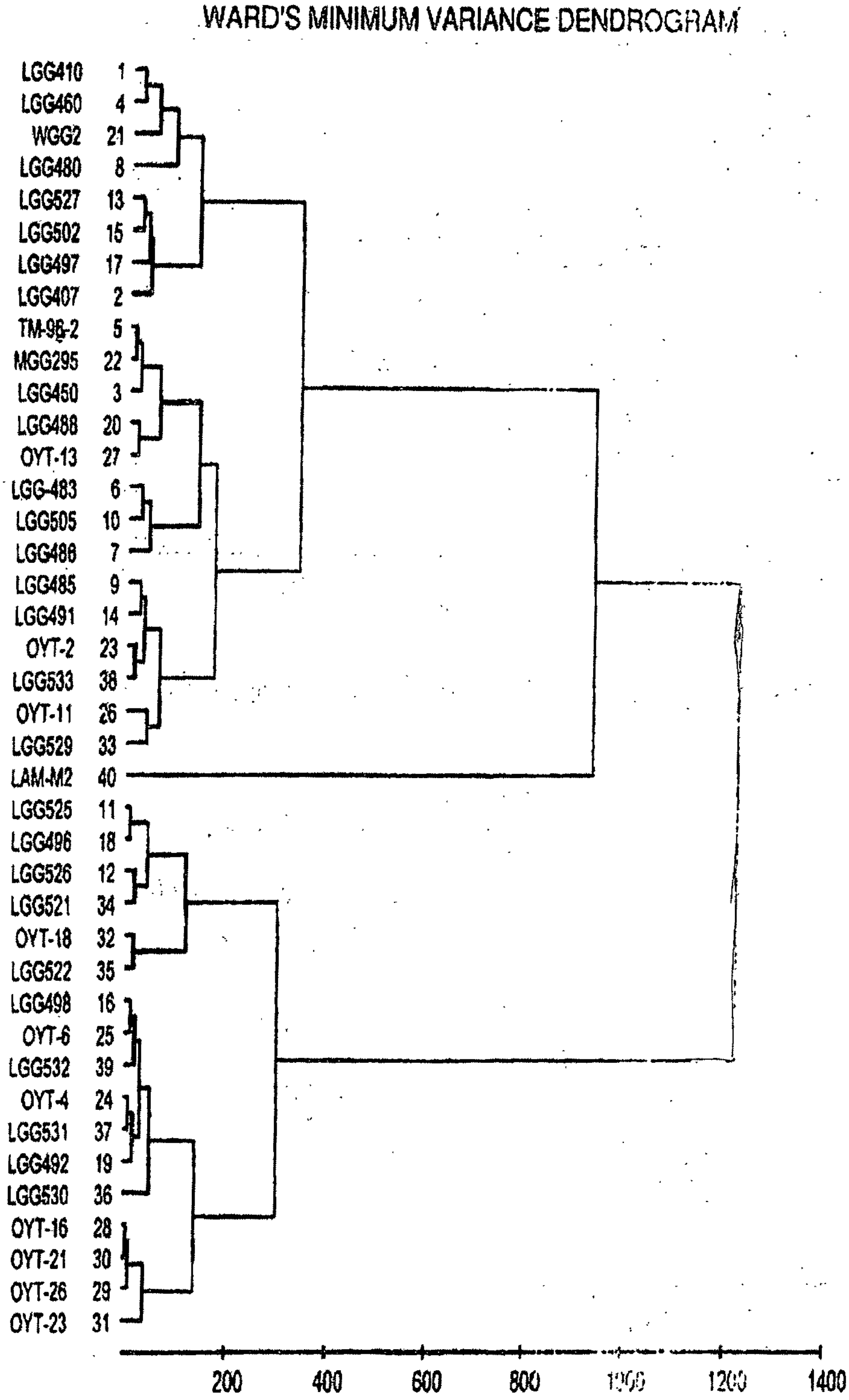

Fig. 1 Dendrogram portraying hierarchical clustering pattern of 40 greengram genotypes

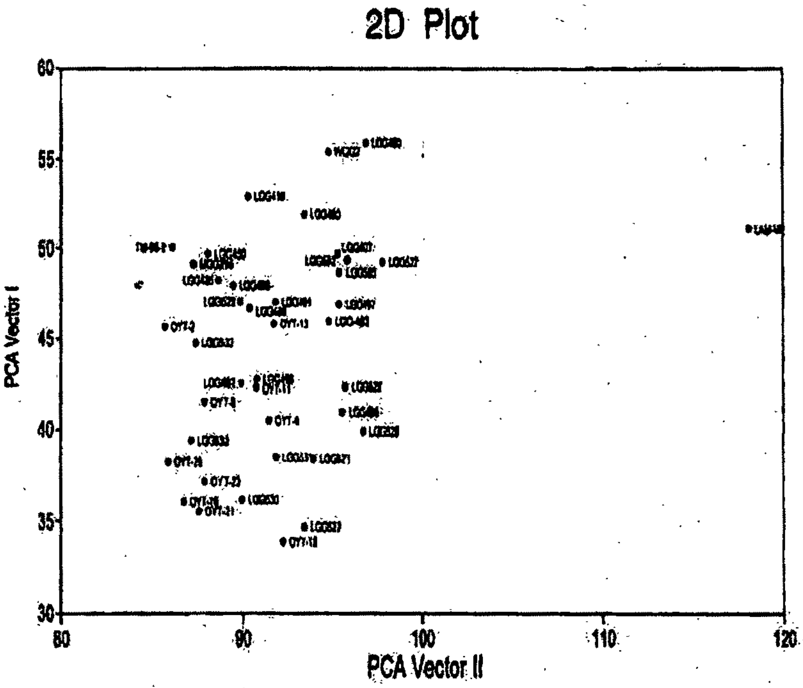

Fig. 2 : 2D plot showing scattering of 40 greengram genotypes (as per Table 1)

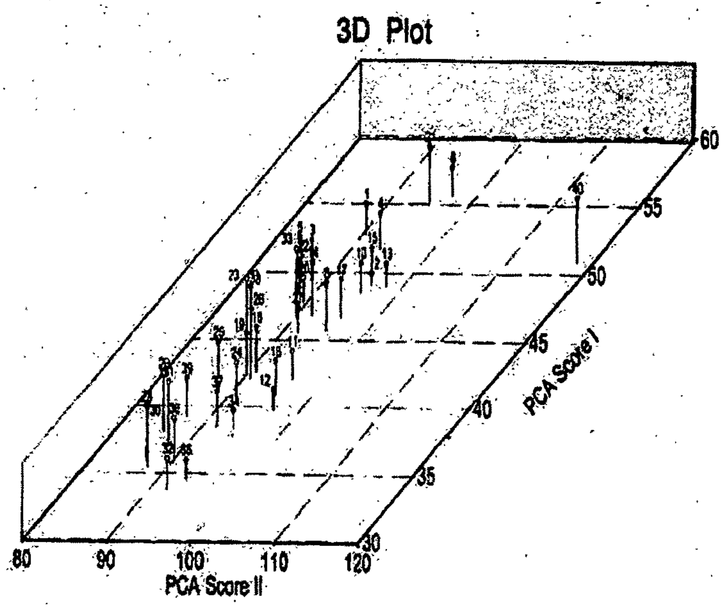

Fig. 3 : 3D plot showing scattering of 40 greengram genotypes (as per Table 1)

Table 4: Intra- and inter-cluster distance values of seven clusters (based on cluster analysis) estimated for 40 genotypes of greengram

Cluster	I	II	III	IV	V	VI	VII
I	**103.33**	127.31	190.71	907.00	296.82	242.45	438.95
II		**86.35**	110.56	1079.88	210.49	139.61	261.25
III			**62.36**	1140.81	228.06	103.91	151.76
IV				**0.00**	1128.32	1221.67	1427.56
V					**77.49**	107.32	190.15
VI						**42.36**	84.93
VII							**34.28**

Bold and diagonal values indicate intra-cluster distance.

Table 5: Contribution of different characters towards genetic divergence among 40 genotypes of greengram [*Vigna radiata* (L.) Wilczek]

Character	Times ranked 1st	Contribution in percentage
Days to 50% flowering	147	18.85
Days to maturity	76	9.74
Plant height (cm)	0	0.00
No. of Primary branches / plant	250	32.05
No. of clusters / plant	10	1.28
No. of pods/cluster	13	1.67
Pod length (cm)	7	0.90
No. of seeds epr pod	0	0.00
100-seed weight (g)	55	7.05
Protein content (%)	219	28.08
Seed yield per plant	3	0.38

Table 5: Eigen value, per cent and cumulative variance in greengram for four PC's

	PC1	PC2	PC3	PC4
Eigen value	5.08	2.19	1.43	0.92
% of variance explained	46.18	19.93	13.8	8.38
Cumulative variance explained	46.18	66.11	79.19	87.50

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Genetic Divergence in Frenchbean (*Phaseolus vulgaris* L.)

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ABSTRACT

Genetic divergence was assessed among 33 genotypes of Frenchbean (*Phaseolus vulgaris* L.) for 14 characters using Mahalanobis' D^2 statistic, cluster analysis and principal component analysis. Based on these clustering methods 8 and 6 clusters were formed for D^2 statistics and cluster analysis, respectively. Days to 50% flowering contributed maximum towards diversity in D^2 analysis and principal component analysis identified 5 principal components with eigen value more than one which contributed 77.66 per cent of cumulative variance. Highest inter-cluster distance was observed between cluster VI and VII followed by cluster V and VII in D^2 statistic. Whereas cluster II and cluster V followed by cluster IV and cluster VI in hierarchical cluster analysis. The clustering pattern of the genotype was to be independent of their eco-geographical origin. On the basis of these clustering methods, crosses may be effective between the genotypes of the clusters, where the inter-cluster distance was high and will yield new desirable recombinants in Frenchbean.

Key words : Frenchbean, Genetic Diversity, Cluster Analysis, Principal Component Analysis

Frenchbean is important food legume crop in India. Genetic diversity plays an important role because hybrids between lines of diverse origin, generally, display a greater heterosis than those between closely related parents. Genetic diversity is a basic criterion for the continued improvement of the crop whether through natural selection or direct plant breeding. Therefore, an attempt was made to study genetic divergence in 33 genotypes of Frenchbean through different methods of cluster *i.e.*, D^2 statistic, cluster and principal component analyses (PCA).

MATERIAL AND METHODS

The experiment was carried out during *rabi* 2005-06 in Agricultural Research Station, Madhira, Khammam, Andhra Pradesh. The material for the present investigation consisted of 33 genotypes of Frenchbean collected across the country (Table 1). These genotypes were sown in randomized block design with three replications. Each genotype was sown in two rows of 3 m length with inter- and intra-row spacing of 30x10 cm. Data were recorded on five randomly selected plants from each replication and genotype for plant height, number of clusters per plant, number of pods per plant, pod length, pod girth, number of seeds per pod, pod yield per plant, seed yield per plant, leaf area and harvest index. While plot means were used for days to 50% flowering, days to maturity, 100 seed weight and protein content. The data were analysed using D^2 statistics (Mahalanobis, 1928), hierarchical cluster analysis (Anderberg, 1993) and principal component analysis (Jackson, 1991).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the 33 Frenchbean genotypes indicating substantial genetic variability for all the characters (Table 2). On the basis of D^2 and clustering analysis 8 and 6 clusters were obtained, respectively. Out of the 8 clusters obtained in D^2 analysis, cluster II was the biggest comprising of 9 genotypes closely followed by cluster IV, cluster I and cluster III with 8, 7 and 5 genotypes, respectively, while the remaining 4 clusters were composed of single genotype. Clustering pattern indicated no association between geographical distribution of accessions and genetic divergence. There are forces other than geographical separation, which are responsible for diversity such as natural and artificial selection, exchange of breeding material, genetic drift and environmental variations (Murthy and Arunachalam, 1966). Similar conclusions were derived by Krishnaprasad (1995) and Dikshit *et. al.* (1999).

The average intra-cluster D^2 values ranged from zero (V, VI, VII and VIII) to 166.64 (cluster IV). The maximum inter-cluster distance was observed between cluster VI and cluster VII (709.19) followed by cluster V and VII (706.68) suggesting that the genotypes from these two clusters could be used as donors in hybridization programme for obtaining a wide spectrum of variation among the segregants (Table 4). Days to 50% flowering contributed maximum towards total divergence (23.48%) followed by number of seeds per pod (17.23%), number of clusters per plant (5.51%), pod yield per plant (5.49%) and

Table 1: List of genotyeps and their source

S.No.	Genotypes	Origin
1	Arkakomal	IIVR- Varanasi
2	IVFB-1	IIVR- Varanasi
3	IVRFB-1	IIVR- Varanasi
4	IVRFB-2	IIVR- Varanasi
5	MFB-1	IIVR- Varanasi
6	MFB-2	IIVR- Varanasi
7	IIHR-909	IIVR- Varanasi
8	Chintapallired	Local collection
9	HUR-909	BHU-Varanasi
10	HUR-135	BHU-Varanasi
11	HUR-32	BHU-Varanasi
12	HUR-69-1	BHU-Varanasi
13	HUR-316	BHU-Varanasi
14	PDR-14	IIPR-Kanpur
15	HUR-342-B	BHU-Varanasi
16	HUR-15	BHU-Varanasi
17	HUR-68	BHU-Varanasi
18	HUR-276	BHU-Varanasi
19	PDR-219-B	IIPR-Kanpur
20	HUR-198	BHU-Varanasi
21	HUR-50	BHU-Varanasi
22	SVM-97R	HPKV-Palampur
23	HUR-616	BHU-Varanasi
24	HUR-445	BHU-Varanasi
25	HUR-140	BHU-Varanasi
26	HUR-80	BHU-Varanasi
27	PDR-317B	IIPR - Kanpur
28	CPR-1	Local collection
29	CPR-2	Local collection
30	PDR-584	IIPR-Kanpur
31	HUR-10A	BHU-Varanasi
32	HUR-53	BHU-Varanasi
33	HUR-158	BHU-Varanasi

Table 2 : Clutering of 33 Frenchbean (Phaseolus vulgaris L.) genotypes by Tocher's method.

Cluster	Genotypes	Name of genotypes
I	7	HUR-32, PDR-317B, PDR-219B, HUR-198, MFB-1, HUR 342-B, MFB-2
I	9	Arkakomal, SVM-97R, HUR-69-1, PDR-584, IVRFB-2, IIHR-909, HUR-80, HUR-10A, HUR-53
III	5	CPR-1, CPR-2, HUR-140, HUR-135, HUR-909
IV	8	HUR-316, HUR-68, PDR-14, HUR-15, Chintapallired, HUR-158, HUR-445, IVFB-1
V	1	HUR-50
VI	1	HUR-276
VII	1	HUR-616
VIII	1	IVRFB-1

Table 3 : Clutering of 33 Frenchbean (Phaseolus vulgaris L.) genotypes by Ward's minimum variance method.

Cluster	Genotypes	Name of genotypes
I	12	Arkakomal, SVM-97R, HUR-69-1, PDR-584, IVRFB-2, HUR-50, IIHR-909, HUR-80, HUR-445, HUR-32, PDR-317B, HUR-10
I	7	HUR-135, HUR-140, CPR-1, CPR-2, HUR-909, HUR-276, HUR-53
III	6	MFB-1, MFB-2, HUR-342, PDR-219B, HUR-198, IVFB-1
IV	1	IVRFB-1
V	3	Chintapallired, HUR-158, HUR-616
VI	4	HUR-316, HUR-68, PDR-14, HUR-15.

days to maturity (5.11%) (Table 8). Similar results were reported by Ghafoor *et. al.* (2001).

The relative importance of contribution of the yield components towards divergence can be judged by comparing the group means of 14 characters (Table 6). The highest mean value for plant height (37.07), number of clusters per plant (5.68), number of seeds per pod (4.51), pod yield (24.79), seed yield (14.48) and harvest index (30.44) were depicted by cluster III (CPR-1, CPR-2, HUR-140, HUR-135 and HUR-909). Cluster IV (HUR-316, HUR-68, PDR-14, HUR-15, Chintapallired, HUR-158 and HUR-445) recorded high mean values for pod girth (3.25), while cluster V (HUR-50) noticed high mean value for protein content (25.96). Cluster VI (HUR-276) noticed high mean value for pods per plant (12.20) and 100 seed weight (43.20); cluster VII (HUR-616) recorded high mean value for days to 50% flowering (53.67), days to maturity (100.33) and cluster VIII revealed high mean value for leaf area (464.06) and pod length (13.69).

Principal component analysis (PCA) identified five principal components with eigen value more than one which contributed 77.66 per cent of cumulative variance (Table 9). The first principal component (PC_1) contributed maximum towards variability (28.60%) with a positive significant loading of harvest index (0.3857) followed by days to 50% flowering (0.3690), days to maturity (0.3294) and pod yield per plant (0.3072). Whereas, seed yield per plant (-0.1472) was negatively correlated. The second principal component (PC_2) accounted for 17.93 per cent of total variance and it reflected significant positive loading of seed yield per plant (0.5091) followed by pod girth (0.4514), plant height (0.3988) and pod yield per plant (0.3349). The third principal component PC_3 was characterized by conspicuously high loading of protein (-0.4304). Based on these first three principal components mean genotype scores were computed. Principal factor scores for all the 33 genotypes were estimated in all 3 PCs and utilized to construct precise 2D and 3D plots (Fig. 2 and 3). All the genotypes were plotted for PC_1 PC_2 and PC_3 which cumulatively explained 63.13% variability accounted for all the characters.

The plot of PC_1, PC_2 and PC_3 showed character differentiation of genotypes according to their cluster membership for each cluster. Genotypes belonging to a common cluster have fallen near to each other and vice-versa. The mean score of genotypes were used as input for clustering in order to group the genotypes into various clusters. Hierarchical clustering

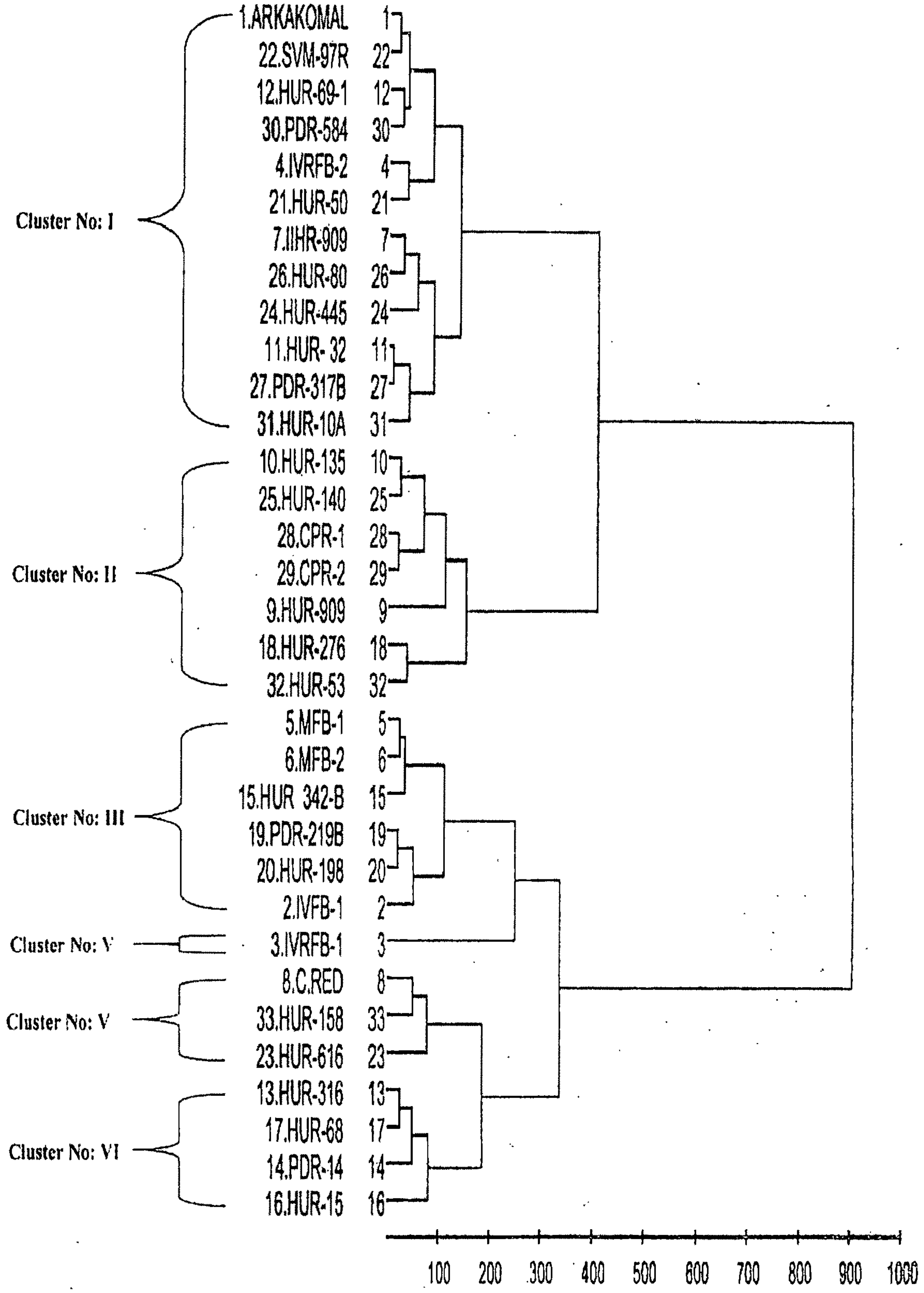

Fig 1: Diagram illustrating the cluster pattern by the Ward's minimum variance method.

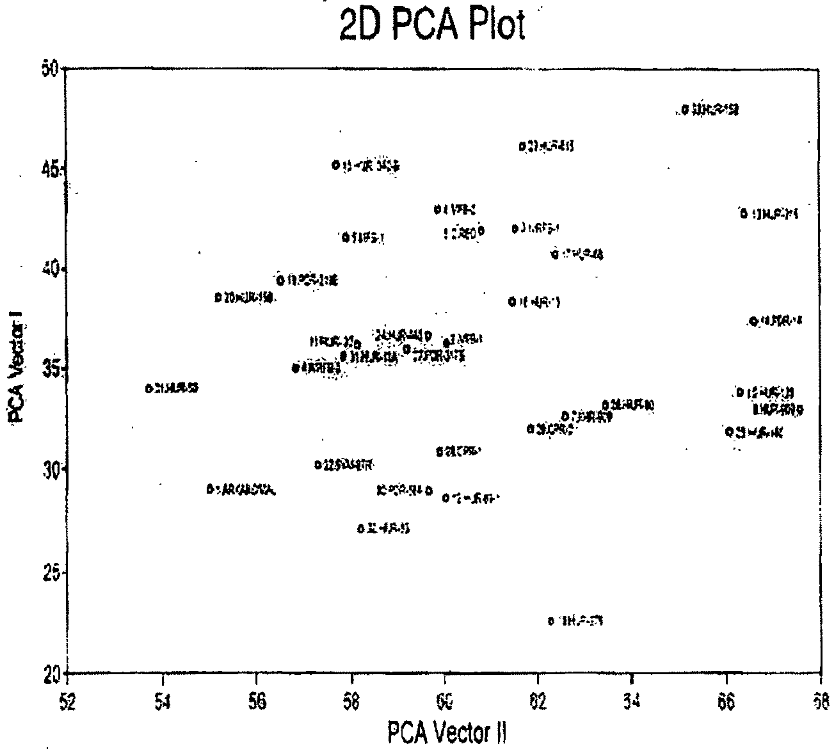

Fig 2: Two-dimensional graph showing relative position of frenchbean (*Phaseolus vulgaris* L.) genotypes based on PCA score.

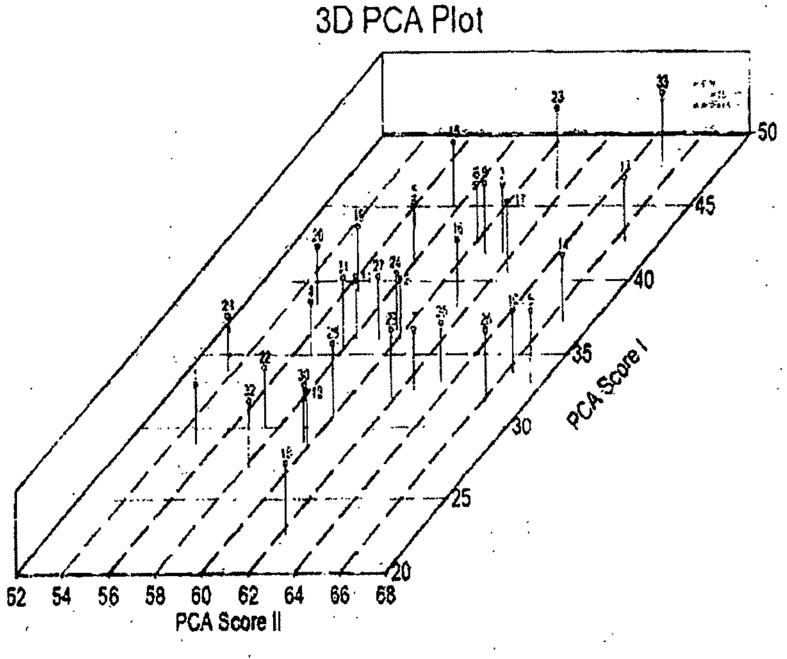

Fig 3: Three-dimensional graph showing relative position of frenchbean (*Phaseolus vulgaris* L.) genotypes based on PCA score.

Table 4 : Inter- and intra- (bold) cluster distance between 8 clustes formed by Mahalanobis' D^2 method in 33 Frenchbean (Phaseolus vulgaris L.) genotypes.

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI	Cluster VII	Cluster VIII
Cluster I	**77.98**	184.28	240.83	156.76	146.38	490.35	364.08	281.99
Cluster II		**96.86**	180.47	255.50	139.65	217.28	565.92	426.72
Cluster III			**111.86**	238.84	319.20	189.50	417.66	320.97
Cluster IV				**166.64**	301.33	470.98	290.56	362.06
Cluster V					**0.00**	438.14	706.68	419.04
Cluster VI						**0.00**	709.14	651.47
Cluster VII							**0.00**	434.23
Cluster VIII								**0.00**

Bold and diagonal values represent intra-cluster distances.

Table 5 : Inter- and intra- (bold) cluster distance between 6 clustes formed by Ward's minimum variance method in 33 Frenchbean (Phaseolus vulgaris L.) genotypes.

	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Cluster VI
Cluster I	**100.81**	197.54	173.37	385.50	389.38	217.15
Cluster II		**137.77**	322.10	382.66	397.22	270.86
Cluster III			**94.65**	331.06	245.42	186.01
Cluster IV				**0.00**	317.86	393.95
Cluster V					**128.11**	189.53
Cluster VI						**102.69**

Bold and diagonal values represent intra-cluster distances.

Table 6: Mean values of eight clusters obtained by Tocher's method estimated from genotypes of Frenchbean (Phaseolus vulgaris L.) during rabi, 2005-06

Cluster	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of clusters / plant	No. of pods / plant	Pod length (cm)	Pod girth (cm)	No. of seeds / pod	100 seed weight (g)	Pod yield /plant (g)	seed yield / plant (g)	Leaf area (cm^2)	Harvest index (%)	Protein content (%)
Cluster I	41.19	84.52	34.11	3.99	7.68	11.74	3.02	4.04	27.84	17.24	8.37	376.60	23.29	22.03
Cluster II	36.04	80.11	31.40	4.49	8.00	12.41	3.03	4.15	35.59	20.47	11.77	366.97	27.39	20.91
Cluster III	41.60	85.60	37.07	5.68	11.15	12.19	3.18	4.51	35.44	24.79	14.48	400.51	30.44	19.87
Cluster IV	45.13	88.25	36.61	4.17	8.68	11.85	3.25	4.12	30.92	17.97	11.48	369.36	26.59	22.06
Cluster V	34.33	76.33	27.47	4.13	6.07	10.57	3.05	3.67	31.18	17.20	10.20	373.76	24.46	25.96
Cluster VI	37.33	80.33	27.07	5.27	12.20	12.18	3.11	3.73	43.20	22.33	12.67	384.93	27.08	18.96
Cluster VII	53.67	100.33	28.33	4.23	7.40	10.07	3.13	3.87	29.76	13.87	6.53	384.66	20.18	14.87
Cluster VIII	45.53	86.67	33.07	4.33	7.20	13.69	3.03	3.87	31.19	21.93	9.33	464.06	25.24	22.75

Table 7: Mean values of six clusters (obtained by Ward's minimum variance method) estimated from genotypes of Frenchbean (Phaseolus vulgaris L.) during rabi, 2005-06

Cluster	Days to 50% flower-ing	Days to maturity	Plant height (cm)	No. of clusters / plant	No. of pods / plant	Pod length (cm)	Pod girth (cm)	No. of seeds / pod	100 seed weight (g)	Pod yield / plant (g)	seed yield / plant (g)	Leaf area (cm²)	Harvest index (%)	Protein content (%)
Cluster I	36.72	80.91	32.06	4.45	7.8	12.20	3.07	4.07	33.88	19.16	11.07	369.18	26.24	22.22
Cluster II	40.09	84.09	34.34	5.49	10.9	12.18	3.12	4.28	37.16	23.89	13.46	396.58	29.08	19.44
Cluster III	42.16	84.11	35.80	4.18	7.9	11.83	3.06	4.01	26.58	16.77	8.09	371.35	23.84	22.15
Cluster IV	45.33	86.67	33.06	4.33	7.2	13.68	3.02	3.86	31.19	21.93	9.33	464.06	25.23	22.74
Cluster V	50.66	95.11	32.57	4.25	7.6	11.02	3.06	4.02	27.93	17.91	11.11	385.80	26.18	18.17
Cluster VI	45.16	88.50	36.16	3.49	8.81	11.63	3.31	4.31	33.43	18.58	12.25	361.96	26.48	21.94

Table 8 : Contribution of each character to the diversity in Frenchbean.

Character	Times ranked 1st	Contribution in %
Days to 50% flowering	124	23.48
Days to maturity	27	5.11
Plant height (cm)	59	11.17
No. of clusters / plant	71	13.45
No. of pods / plant	18	3.41
Pod length (cm)	14	2.65
Pod girth (cm)	9	1.70
No. of seeds / pod	91	17.23
100 seed weight (g)	13	2.46
Pod yield / plant (g)	29	5.49
Seed yield / plant (g)	30	5.51
Leaf area (cm²)	6	1.14
Harvest index (%)	22	4.17
Protein (%)	16	3.03

Table 9 : Eigen values, proportion of the total variance represented by first six principal components, cumulative per cent variance and component loading of different characters in Frenchbean (Phaseolus vulgaris L).

	PC1	PC2	PC3	PC4	PC5	PC6
Eigen value	4.00483	2.51062	2.04306	1.28099	1.03401	0.97246
% Var. exp	28.60591	17.93297	14.5332	9.14990	7.38579	6.94611
Cum. Var. exp	28.60591	46.53888	61.13219	70.28209	77.66788	84.61398
Days to 50% flowering	0.36900	0.19939	0.32204	0.13279	0.20170	0.06123
Days to maturity	0.32946	0.23271	0.41044	0.07341	0.02452	0.11402
Plant height (cm)	0.21229	0.39887	-0.22308	-0.14825	0.15567	0.08082
No. of clusters / plant	-0.38775	0.03275	-0.02041	-0.23414	0.38882	0.02673
No. of pods / plant	-0.29775	0.18360	0.21856	0.11501	0.58687	-0.02796
Pod length (cm)	-0.16027	0.22463	-0.37738	-0.40491	-0.00717	0.03852
Pod girth (cm)	-0.06562	0.45144	-0.22552	0.24068	0.23295	0.25664
No. of seeds / pod	0.13061	0.02651	-0.23634	0.17573	0.16643	-0.85351
100 seed weight (g)	-0.28084	0.24329	0.26384	-0.11554	-0.42988	0.03097
Pod yield / plant (g)	0.30728	0.33431	-0.13117	-0.21947	-0.18604	-0.12484
Seed yield / plant (g)	-0.14724	0.50914	0.14079	0.12831	-0.26239	-0.24748
Leaf area (cm²)	0.04613	0.02334	0.26947	-0.71826	0.11060	-0.17304
Harvest index (%)	0.38573	-0.16247	0.12748	-0.19952	0.23711	0.00765
Protein (%)	0.27979	-0.01166	-0.43040	-0.02264	0.01287	0.26760

procedure (Ward's method) divided 33 genotypes into 6 clusters (Table 3 and Fig.1). This also reflect that there was no relation between eco-geographical difference and genetic diversity as in the case of D^2 analysis.

The biggest cluster was I (12 genotypes) followed by cluster II (8 genotypes). Based on cluster analysis the intra- cluster values ranged from zero (cluster IV) to 137.78 (cluster II). The maximum inter- cluster distance was observed between cluster II and V (397.22) followed by cluster IV and cluster VI (393.95) and cluster I and cluster V (389.38) as shown in Table 5. Cluster II (HUR-135, HUR-140, CPR-1, CPR-2, HUR- 909, HUR-276 and HUR-53) is characterized by high mean value for number of clusters per plant (5.49), number of pods per plant (10.99), 100 seed weight (37.16), pod yield per plant (23.89), seed yield per plant (13.46) and harvest index (29.08); cluster IV (IVRFB-1) recorded high mean for pod length (13.68), leaf area (464.06) and protein content (22.74); cluster V (Chintapallired, HUR-158 and HUR-616) registered high mean value for days to maturity (95.11); cluster VI (HUR-316, HUR-68, PDR-14 and HUR-15) recorded high mean value for plant height (36.16), pod girth(3.31) and number of seeds per pod (4.31) as shown in Table 7. Based on cluster analysis crosses may be effective between the genotypes of II, V and IV, VI clusters to obtain better and desirable segregants. Utilization of principal component analysis combined with hierarchical cluster analysis in genetic diversity studies was also reported by Subramanian and Muthaiah (2003).

In broad sense, the two methods of classifying genotypes into different groups is equally useful, but cluster analysis had an additional advantage of sub-clustering of the major groups at different levels so that each small group can be critically analyzed. Apart from the high divergence, the performance of genotypes, the characters with maximum contribution towards divergence should also be given due consideration. While selection due emphasis should be given to days to 50% flowering, number of seeds per pod, number of clusters per plant and pod yield per plant. The genotypes HUR-276, HUR-616, HUR-50, CPR-1 and CPR-2 appear to be best parents to produce desirable segregants for yield in Frenchbean.

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Journal
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General Selection Indices in Finger Millet [*Eleusine coracana* (L.)Gaertn.]

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ABSTRACT

General selection indices study in thirty VMCE and fifty AICSMIP genotypes revealed that the discriminant functions including ear weight per plant, yield per plant and 1000 seed weight should be given prime importance while making selection. In the other five groups namely, VMCE *kharif* group and AICSMIP *kharif* group, VMCE *kharif* group and AICSMIP *rabi* group, VMCE *rabi* group and AICSMIP *kharif* group, VMCE *rabi* group and *AICSMIP* rabi *group, AICSMIP kharif* group and AISCIP *rabi* group the discriminant function obtained indicated that each of these groups differ widely in their character behaviour as evidenced from negative values for the characters. Therefore, selection criterion should be specified for each of these groups separately.

Key words : Finger Millet, General Selection Indices

In general selection indices all the characters under study are considered unlike other selection methods where in one or the other character under study is restricted at a time. The concept of general selection indices is of great utility since the construction of new selection indices for every population, every year, every season and for every place is cumbersome. Caldwell and Weber (1965) reported that the three steps necessary for the construction of general selection indices were (1) estimation of bi values from pooled informations available from various populations, (2) using bi values, development of correction factors for phenotypic and genotypic variances and covariances and (3) calculation of a set of new bi values using corrected, pooled variances and covariances.

In this study the general selection indices in finger millet are attempted by combining two groups of genotypes from local conditions, 30 genotypes from Agricultural Research Station (ARS) Vizianagaram and Agricultural Research Station (ARS), Chintapalli and 50 genotypes from All India Coordinated Small Millets Improvement Project (AICSMIP), Bangalore, and also pooling data from two seasons i.e., *kharif* 2005 and *rabi* 2005-06 making six population combinations.

MATERIAL AND METHODS

The present investigation was conducted during two consecutive seasons of *kharif* 2005 and *rabi* 2005-06 at Agricultural College Farm, Bapatla. Thirty local genotypes from Agricultural Research Station (ARS) Vizianagaram and Agricultural Research Station (ARS), Chintapalli (VMCE genotypes) and 50 genotypes from All India Coordinated Small Millets Improvement Project, Bangalore (AICSMIP genotypes) were evaluated separately in randomized block design with four replications. Observations were recorded on five randomly chosen plants for each replication and genotype for productive tillers per plant, ear weight per plant, yield per plant, 1000 seed weight, protein content and seed calcium content. General selection indices were computed as per Hanson and Johnson (1957).

RESULTS AND DISCUSSION

Discriminant functions were computed as per Hanson and Johnson (1957) based on the yield and yield components recorded taking two populations at a time i.e., VMEC *kharif* group and VMEC *rabi* group (I pool), VMEC *kharif* group and AICSMIP *kharif* group (II pool), VMEC *kharif* group and AICSMIP *rabi* group (III pool), VMEC *rabi* group and AICSMIP *kharif* group (IV pool), VMEC *rabi* group and AICSMIP *rabi* group (V pool), AICSMIP *kharif* group and AICSMIP *rabi* group (VI pool). Weighing coefficient values were calculated and presented in Table.

In the first pooling of VMEC *kharif* group and VMEC *rabi* group the discriminant function indicated the prime importance should be given to ear weight per plant, yield per plant and 100 seed weight while making selection.

In the second pooling of VMEC *kharif* group and AICSMIP *kharif* group and fourth pooling of VMEC *rabi* group and AICSMIP *kharif* group the discriminant function obtained indicates that each of these groups differ widely in their character behavior as evidenced from negative values for the characters. Therefore, selection criterion should be specified for each of these groups separately.

Table : Weighing coefficient (bi) values for six characters in six population pools in general selection indices.

Character	I Pool	II Pool	III Pool	IV Pool	V Pool	VI Pool
Productive tillers / plant	-1.36	-3.72	-130.20	-8.61	-9.72	-8.41
Ear weight / plant (g)	15.61	-21.32	3.42	-4.81	-8.32	-1.37
Yield per plant (g)	39.32	-14.86	2.61	-3.72	15.36	-0.78
1000 seed weight (g)	28.26	-2.19	-0.89	-5.68	-21.36	1.73
Protein content (%)	-10.31	-1.81	-92.6	-210.71	-170.36	-0.06
Seed calcium (mg/100g)	-16.42	-2.13	-71.3	-15.36	-10.32	-2.16

I Pool : VMEC *kharif* group and VMEC *rabi* group
II Pool : VMEC *kharif* group and AICSMIP *kharif* group
III Pool : VMEC *kharif* group and AICSMIP *rabi* group
IV Pool : VMEC *rabi* group and AICSMIP *kharif* group
V Pool : VMEC *rabi* group and AICSMIP *rabi* group
VI Pool : AICSMIP *kharif* group and AICSMIP *rabi* group

In the third pooling of VMEC *kharif* group and AICSMIP *rabi* group, ear weight per plant (3.42) and yield per plant (2.61) may be improved to certain extent using general selection indices. In the fifth pooling of VMEC *rabi* group and AICSMIP *rabi* group, little gain may be obtained for yield per plant (15.36) as this is the only component which has the positive value for bi. In the sixth pooling of AICSMIP *kharif* group and AICSMIP *rabi* group slight improvement may be obtained for 1000 seed weight (1.73). Similarly general selection indices were studied involving Virgina bunch, Virginia runner and Spanish bunch types of groundnut (Venkateswara Rao, 1985 and Panduranga Rao *et. al.*, 1988).

This study clearly indicates the importance of yield per plant and 100 seed weight in selection indices.

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Selection Indices in Sesamum (*Sesamum indicum* L.)

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ABSTRACT

Selection indices studies in 17 genotypes of sesamum using discriminant function technique revealed that the functions including number of seeds per capsule as one of the components recorded high expected genetic advance and relative efficiency. The index in which all the seven characters were included showed maximum genetic advance and relative efficiency suggesting that simultaneous selection for all these characters would be better over straight selection for seed yield.

Key words : Selection Indices, Genetic Advance and Sesamum.

Considerable emphasis is currently being placed upon the improvement of yield through simultaneous selection for various yield attributes. The discriminant function affords an efficient method for simultaneous selection (Smith, 1936). So attempts are made in this investigation to assess the relative efficacy of different selection indices formulated through the use of discriminant function technique.

MATERIAL AND METHODS

Seventeen genotypes of sesamum were evaluated for nine characters *i.e.*, plant height, days to 50% flowering, days to maturity, number of primaries, number of capsules per plant, number of seeds per capsules, 1000 seed weight, seed yield per plant and oils content (%). All the 17 genotypes *i.e.*, five parents and F_2, F_3 and F_4 of four crosses were grown in a randomized block design with three replications at Agricultural College Farm, Bapatla during *rabi* 2006. Each parent consisted of single row of 4 m length and each segregating generation consisted of 5 rows of 4 m length. Each parent consisted of 40 plants and each segregating progeny *i.e.*, F_2, F_3 and F_4 consisted of 200 plants for taking observations.

The mean values of five plants were used to construct different selection indices based on the Fisher's (1936) discriminant function. The expected genetic advance an relative efficiency in percentage were computed according to Brim *et. al.* (1959).

RESULTS AND DISCUSSION

Classical selection indices

The economic weights (a_i values) allotted for each character along with weighing coefficients (b_i values) are presented in Table 1. Inverse of mean value for respective characters were considered as allotted weight. Among the characters 1000 seed weight got the highest weightage (0.35) followed by number of primaries (0.34) and seed yield per plant (0.09). In weighing coefficient values number of primaries showed high b_i value (0.259) followed by seed yield per plant and 1000 seed weight.

Selection criteria

The selection criteria for the 17 genotypes of sesamum are given in Table 2. Higher values of selection criteria were observed for the genotypes Gowri (4.339), Madhavi (4.215), Vinayak (4.418), Madhavi x Vinayak F_2 (4.017) and Gowri x SO – 12-2154 F_3 (3.878), while the lowest was observed for the genotype Tanuku Brown (3.354). Surekha and Rama Kumar (2005) observed a linear increase in genetic advance and relative efficiencies with the inclusion of more number of characters in the index along with seed yield per plant.

Selection indices comprising various combinations of characters along with their genetic advance and relative efficiency are presented in Table 3. Among the two component character indices along with seed yield and number of seeds per capsule showed highest genetic advance (0.25%) with a relative efficiency of (139.17%). The other component characters that exhibited higher values of genetic advance and relative efficiency in combination with seed yield were number of capsules per plant (0.22 and 121.03) and plant height (0.21 and 113.36). Like wise three character combinations showed still higher genetic advance. The maximum genetic advance of (0.35) and relative efficiency of (194.42%) were shown when all the seven characters *i.e.*, plant height, days to 50% flowering, days to maturity, number of capsules per plant, number of seeds per capsule and oil

Table 1 : Weighing coefficients (b_1) and economic weights (a_1) for differrent characters in sesamum

Character	b_1 value	a_1 value
Plant height	0.0120	0.01
Days to 50% flowering	0.0100	0.02
Days to maturity	0.0014	0.01
Number of primaries	0.2594	0.34
Number of capsules per plant	0.0247	0.02
Number of seeds per capsule	0.0198	0.02
1000 seed weight	0.0307	0.35
Oil content	0.0047	0.02
Seed yield per plant	0.0486	0.09

Table 2 : Selection criterion values for 17 genotypes of sesamum in classical selection indices

Genotypes	Selection criteria
Madhavi	4.215
Vinayak	4.148
Tanuku Brown	3.354
SO-12-2154	3.775
Gowri	4.339
F_2 Madhavi x SO-12-2154	3.873
F_2 Madhavi x Vinayak	4.017
F_2 Gowri x SO-12-2154	3.814
F_2 Tanuku Brown x Vinayak	3.867
F_3 Madhavi x SO-12-2154	3.778
F_3 Madhavi x Vinayak	3.778
F_3 Gowri x SO-12-2154	3.878
F_3 Tanuku Brown x Vinayak	3.736
F_4 Madhavi x SO-12-2154	3.606
F_4 Madhavi x Vinayak	3.728
F_4 Gowri x SO-12-2154	3.688
F_4 Tanuku Brown x Vinayak	3.710

Table 3 : Selection indices for different character combinations in sesamum

Character combination	Genetic advance (%)	Relative efficiency (%)
Plant height (X_1)	0.02	11.86
Days to 50% flowering (X_2)	0.04	22.50
Days to maturity (X_3)	0.01	4.51
Number of primaries (X_4)	0.02	9.92
Number of capsules per plant (X_5)	0.01	3.30
Number of seeds per capsule (X_6)	0.12	63.96
1000-seed weight (X_7)	0.03	16.21
Oil content (X_8)	0.07	36.28
Seed yield per plant (X_9)	0.18	100.00
$X_9 + X_1$	0.21	113.36
$X_9 + X_2$	0.16	88.87
$X_9 + X_3$	0.19	102.43
$X_9 + X_4$	0.14	75.22
$X_9 + X_5$	0.22	121.03
$X_9 + X_6$	0.25	139.17
$X_9 + X_7$	0.16	85.79
$X_9 + X_8$	0.22	122.33
$X_9 + X_1 + X_6$	0.28	151.54
$X_9 + X_5 + X_6$	0.29	159.48
$X_9 + X_1 + X_5 + X_6$	0.31	172.56
$X_9 + X_5 + X_6 + X_8$	0.32	177.56
$X_9 + X_1 + X_5 + X_6 + X_8$	0.35	190.18
$X_9 + X_1 + X_3 + X_5 + X_6 + X_8$	0.35	193.18
$X_9 + X_1 + X_2 + X_3 + X_5 + X_6 + X_8$	0.35	194.42

content were included in the index.

The other indices with different combinations involving six characters, five characters and four characters gave values of genetic advance and relative efficiency in a relatively descending order.

From the results, it can be concluded that the function including all the seven characters under study viz., plant height, days to 50% flowering, days to maturity, number of capsules per plant, number of seeds per capsule, oil content and seed yield per plant had highest genetic advance and relative efficiency. Khorgade *et. al.* (1998) found that index comprising number of capsules per plant, 1000 seed weight and seed yield per plant had highest genetic advance and relative efficiency in sesamum.

Hence it can be concluded that the inclusion of character one by one the function resulted in the increased efficiency of selection. The indices in which the character number of seeds per capsule is included as one of characters showed high genetic advance and selection efficiency.

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Evaluation of Sugarcane Genotypes Against Key Pests

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ABSTRACT

With a view to evaluate promising genotypes of sugarcane with resistance to key pests of sugarcane namely early shoot borer, internode borer and scale insect, experiments were conducted at Regional Agricultural Research Station, Anakapalle during 2001-2003. The genotype 99 A 173 was found promising by recording significantly less incidence of the early shoot borer (4.00%), less intensity of internode borer (2.06%) and scale insect (2.23%). The genotype 90A 272 was also found promising as it registered less intensity of scale insect and weight of scale encrustation. Among the entries tested, genotype 99 A 173 registered significantly high sucrose (18.84%) and higher cane yield of 122.08 t/ha.

Key words : Sugarcane, Sugarcane Early Shoot Borer, Internode Borer, Scale Insect.

Sugarcane is one of the most important commercial crops in Andhra Pradesh and grown in almost all districts of the state. The cane population is mainly determined by varieties and the failure of commercial varieties after years of cultivation was due to deterioration by insect pests and needs to be replaced by new high yielding varieties with resistance to major pests *viz.*, early shoot borer and internode borer, *Chilo infuscatellus* Snellen, scale insect *Melanaspis glomerata* Green. The cane fly, whitefly, mealy bug and termites, yellow mite, wooly aphid occur sporadically, but some times severely infesting sugarcane crop in isolated pockets under special environmental conditions. Among all insect pests, incidence of early shoot borer, internode borer and scale insect is the major destructive factor for poor yield and poor quality of varieties / clones in main crop as well as ratoon in addition to performance of the variety under various agroclimatic conditions in various soil types. Hence, it is highly imperative to develop the most stable variety for the particular environment with resistance to borers and scale insect. The moths prefer deep green foliage as well as bent and drooping leaves for egg laying. Prabhakara Rao *et. al.* (1976) Nandagopal *et. al.* (1990) Thirumurugan *et. al.* (1999) observed a high positive correlation between borer infestation and high sugar content. The varieties having enveloping, persistent leaf sheaths are more susceptible to scale insect than self-trashing varieties.

MATERIAL AND METHODS

An experiment was laid out at Regional Agricultural Research Station, Anakapalle during 2001-2003 seasons with a view to evaluate performance of promising genotypes / clones for resistance against major insect pests namely, early shoot borer, internode borer and scale insect. The treatments consisted of nine clones with two standard checks replicated thrice in a randomized block design. The plot size was 5m x 0.8 m x 6R. The field was maintained by adopting sound agronomic practices without using plant protection measures. Planting was done with three budded setts. Data on cumulative incidence of early shoot borer upto 120 days, incidence of internode borer, scale insect and scale encrustation were recorded. Data on important parameters like per cent sucrose and cane yield were also recorded at harvest. The data were recorded for two seasons, statistically analyzed and are presented in Table 1 and 2.

RESULTS AND DISCUSSION

Data on cumulative incidence of early shoot borer up to 120 days, intensity of internode borer, intensity of scale insect and scale encrustation are presented in Table 1. The cumulative incidence of early shoot borer was in the range of 4.0 per cent in 99 A 173 to 21.01 per cent in 2000 A 78. Among the nine genotypes and two standards, genotypes namely, 99A 173, 93A 53 and 98A 122 were found promising by recording significantly less incidence of the early shoot borer to an extent of 4.00, 4.97 and 5.65 per cent, respectively.

The intensity of internode borer varied from 2.06 per cent in 99 A 173 to 15.49 per cent in 2000 A 78. All the genotypes except 2000 A 78 registered less intensity of internode borer *i.e.*, 7.0 per cent. However, the differences were not significant.

Among the nine genotypes and two standards, the intensity of scale insect was in the range of 2.23 per cent in 99 A 173 to 56.78 in 93A 53. Genotype 90 A 272 also has registered

Table 1 : Incidence of early shoot borer, internode borer and scale insect and weight of scale encrustation in the evaluation trial (Pooled analysis*)

Genotype	Cumulative incidence of ESB upto 120 days	% intensity of internode borer	% intensity of scale insect	Weight of scale encrustation (mg/cane)
Co A 98081	18.38 (10.14)	8.93 (2.44)	24.92 (18.01)	135
Co A 98082	25.95 (19.15)	9.64 (3.19)	21.44 (14.02)	56
90 A 272	18.90 (10.97)	8.45 (2.24)	9.11 (2.51)	13
93 A 53	12.77 (4.97)	12.93 (6.01)	49.57 (56.78)	593
93 A 145	15.43 (7.09)	14.75 (7.03)	34.33 (36.56)	445
97 A 78	19.90 (12.26)	13.94 (5.82)	10.25 (3.85)	14
98 A 122	13.72 (5.65)	12.32 (5.11)	29.50 (25.29)	99
99 A 173	11.32 (4.00)	8.03 (2.06)	8.31 (2.23)	11
2000 A 78	27.26 (21.01)	7.14 (15.49)	53.69 (47.12)	790
Co 6907	19.86 (11.62)	8.69 (2.73)	27.44 (21.39)	110
Co 7508	24.23 (17.44)	7.97 (2.05)	19.16 (11.12)	29
S.Em	2.42	1.23	3.55	87.62
S.E. per plot	2.14	6.16	151.76	2.14
C.D.	4.56	10.97	269.98	--
C.V.%	20.15	85.55	27.73	97.40

Figures in parentheses are the actual infestation values.

* Data pertaining to 2001-02 and 2002-03 seasons.

less intensity of scale insect *i.e.*, 2.51 per cent. Among the nine genotypes and two standards tested, the genotypes namely, 99A 173, 90A 272 and 97A 78 recorded the lowest weight of scale encrustation of 11, 13 and 14 mg/cane respectively, whereas the genotype 93A 53 recorded the highest weight of scale encrustation of 593 mg/cane.

Data on per cent sucrose and cane yield were recorded and are presented in Table 2. Among the nine entries and two standards tested, the genotype 99 A 173 registered significantly high sucrose (18.84%) followed by the other genotypes except 93 A 53 which registered significantly less sucrose (12.47%). The highest cane yield of 122.08 t/ha was recorded by the genotype 99 A 173 followed by 97 A 78 which recorded 108.25 t/ha. However, the differences were not significant.

Table 2 : Quality and yield attributes in the evaluation trial (Pooled analysis*)

Genotype	% Sucrose	Cane yield (t/ha)
Co A 98081	16.63	107.00
Co A 98082	16.07	97.83
90 A 272	15.57	104.66
93 A 53	15.47	102.38
93 A 145	15.21	105.25
97 A 78	14.85	107.34
98 A 122	14.03	98.55
99 A 173	18.84	122.08
2000 A 78	16.48	92.92
Co 6907	15.82	108.25
Co 7508	19.07	114.58
S.Em	0.36	9.85
S.E. per plot	0.62	17.06
C.D.	1.56	--
C.V.%	3.7	16.3

* Data pertaining to 2001-02 and 2002-03 seasons.

The results indicate that the genotype 99A 173 was found promising by recording significantly less incidence of the early shoot borer, internode borer and scale insect. The lower incidence may be ascribed to deep green foliage as well as bent and drooping leaves of 99A 173 and these characters may be congenial for egg laying of female moth. Prabhakara Rao *et. al.* (1976), Nandagopal *et. al.* (1990) and Thirumurugan *et. al.* (1999) who also observed a high positive correlation between borer infestation and high sugar content. The genotype 99A 173 and 90A 272 were also found promising as they registered less intensity of scale insect and weight of sale encrustation. The varieties having enveloping, persistent leaf sheaths are more susceptible to scale insect than self-trashing varieties. Among the entries tested, genotype 99A173 registered significantly high sucrose (18.84%) and cane yield of 122.08 t/ha. Hence, it is concluded that the genotype 99A173 was found to be promising as it registered lower incidence of all the key pests of sugarcane with desirable qualitative and quantitative traits. This clone may be better fitted in the breeding programme as one of the parents for offering resistance to major insect pests of the area.

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Quantitative Changes in Biochemical Spectrum of *Epilachna vigintioctopunctata* (Fab.) (Coccinellidae : Coleoptera) *Helicoverpa armigera* (Hub.) and *Spodoptera litura* (Fab.) (Noctuidae : Lepidoptera) due to Calotropis gigantea *R. Br. Plant Parts Treatment*

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ABSTRACT

The changes in the biochemical constituents of *Epilachna vigintioctopunctata* (Fab.) grub, *Helicoverpa armigera* (Hub.) and *Spodoptera litura* (Fab.) larvae due to feeding on host leaves treated with *Calotropis gigantea* R. Br. plant parts petroleum ether extract were studied under laboratory condition. The results revealed that the leaf and flower petroleum ether extract of *C. gigantea* significantly reduced the biochemical content (protein, lipid, sugar and chitin) in test insects, compared to control.

Key words : Epilachna, Helicoverpa, Spodoptera, Calotropis

Epilachna vigintioctopunctata F. is the one of the serious pests of brinjal, causing defoliation (Rosaiah, 2001). *Helicoverpa armigera* Hub. and *Spodotpera litura* Fab. are the two important polyphagous lepidopteran pests of several crops. To manage the above pests although several insecticides are used against the above pests in India but due to the development of resistance by the above pests against many of the synthetic insecticides environmental pollution, as an alternative method of management, botanicals being easily biodegradable and having low mammalian toxicity appear to be the best especially for insect pests of vegetable crops, which have to be residue free due to their high cosmetic value. As the botanical contains diverse bioactive ingredients with more than one mode of action, they produce cumulative behavioural and physiological effects and consequently it will be difficult to develop resistance against such compounds (Senthilnathan *et. al.*, 2004). *C. gigantea* is the weed plant growing in waste lands and road sides and possesses insecticidal properties (Solunke and Deshpande, 1991). The present investigation was carried out to determine the effect of *C. gigantea* plant parts of biochemical contents of above test insects.

MATERIAL AND METHODS

Stock culture of test insects was maintained under non-regulated room temperature and humidity. *E. vigintioctopunctata* egg masses were collected from the brinjal field and transferred into the brinjal leaves in the plastic tray. The newly emerged grubs were fed brinjal leaves and the culture was maintained. *H. armigera* eggs were colleted from the tomato field and allowed for emergence. The newly emerged neonates were carefully transferred into the 40 days old potted tomato plants with the use of camel hairbrush. Third instar larvae were transferred into the multicavity tray containing bhendi fruit pieces and the culture was maintained. *S. litura* egg mass were collected from the castor field and newly emerged larvae were fed castor leaves.

C. gigantean leaf and flower were collected, shade dried, ground with the help of willeymill. 200 g of powdered material was taken and extracted in 500 ml of petroleum ether in a Soxhlet apparatus. From the stock solution, 5% concentration was prepared on weight / volume basis by mixing 5 g crude extract with 95 ml of acetone (Arul Prakash, 2004). The leaves of brinjal, bhendi fruit and castor leaves were immersed in 5% petroleum ether extract of flower and leaves of *C. gigantea* for 5 minutes, air dried to remove the solvent and fed *E. vigintioctopunctata* fourth instar grub, *H. armigera* and *S. litura* fourth instar larvae, respectively for 24 hrs. After 24 hrs, larvae were weighted and killed using solvent acetone and used for estimation of biochemical constituents. Each treatment was replicated 3 times. Healthy larvae served as control.

Total protein content was estimated by Folinciocalteau method (Lowry *et. al.*, 1951). Protein forms complex with copper ions in the alkali medium and this complex produces dark blue colour in the proteins which reduce phosphomolybdate and tungstate of Folinphenol reagent. The colour developed was read at 660 nm and from the absorbency of known volume of the standard protein, the absolute value of protein content in the sample was calculated.

The sugar content of the insect body was quantified spectrophotometrically by employing dinitro salicylic method. The colour developed was read at 510 nm and with absorbency of known volume of standard sugar, the absolute value of sugar content in the samples were calculated (Sadasivam and Manickam, 1996).

Bligh and Dyer method was used to estimate the total lipids present in both the treated and untreated larva (Sadasivam and Manickam, 1996). The sample pulp was prepared by using chloroform, methanol mixture. After centrifugation, three layers were seen. The lower layer of chloroform containing all the lipids were separated and it was collected in a pre-weighed beaker. It was kept overnight and again the weight was determined. The difference in weight gave weight of the lipids.

The skin of the treated dead insects was removed and boiled in 30% KOH for 15 min. Subsequently it was washed six times in distilled water, twice with 96% alcohol and twice with ether. The larval skin was weighed after oven drying at 100°C. larval skin from the untreated larvae served as control and the chitin content was assessed (Grosscurt, 1978).

RESULTS AND DISCUSSION

The protein content in *E. vigintioctopunctata* declined from 16.20 mg/g in healthy grubs to 11.09 and 13.39 mg/g in grubs treated with *C. gigantea* leaf and flower extract, respectively (Table). The amount of sugar was reduced to 14.41 and 16.18 mg/g with *C. gigantea* leaf and flower extract treatment, respectively which was significantly lower than in the healthy insects (18.32 mg/g). The lipids were lowered to 5.20 mg/g with *C. gigantea* leaf extract and 6.10 mg/g in flower extract treated grub compared to control (8.55 mg/g). The chitin concentration declined from 12.44 mg/g in healthy grubs to 11.22 mg/g and 9.43 mg/g in *C. gigantea* flower and leaf extract treated grubs.

H. armigera

Quantitative estimation of protein in the *C. gigantea* leaf and flower extract treated larvae of *H. armigera* showed that the protein concentration declined to 18.29 and 20.24 mg/g respectively compared to (26.03 mg/g) in control. The sugar content also declined from 33.46 mg/g in untreated insects to 28.33 and 26.28 mg/g in flower and leaf extract treated larva. The lipid content was diminished to 8.21 and 6.38 mg/g with *C. gigantea* flower and leaf extract treatment, respectively. The amount of chitin was reduced to 12.53 and 14.31 mg/g in larva treated with leaf and flower extract treatment, which was significantly lower than that in the healthy insects (17.85 mg/g) (Table).

S. litura

S. litura protein content in the *C. gigantea* leaf and flower extract treated larvae was diminished to 23.39 and 25.28 mg/g respectively, whereas protein content in control was 28.56 mg/g. The amount of sugar was noticed to decline to 30.48 mg/g with leaf extract treatment and 33.35 mg/g with flower extract while untreated insect had 38.59 mg/g sugar content. The lipids were declined to 9.35 mg/g with *C. gigantea* leaf extract treatment and 10.45 mg/g in flower extract treatment whereas 13.61 mg/g in healthy insects. The chitin content was reduced to 16.19 and 18.56 mg/g with leaf and flower extract treatment, which was lower than that in the healthy insects (20.54 mg/g) (Table).

The superior effect of treatment in reducing the biochemical content of above test insects might be caused by the influence of *C. gigantea*

Table : Quantitative changes in the biochemical compoentns of *E. vigintioctopunctata* grubs, *H. armigera* and *S. Litura* treated with C. gigantea plant arts extracts

Treatment	Quantity mg/g											
	E. vigintioctopunctata				*H. armigera*				*S. Litura*			
	Protein	Sugar	Lipid	Chitin	Protein	Sugar	Lipid	Chitin	Protein	Sugar	Lipid	Chitin
Leaf extract	11.09^c	14.41^c	5.20^c	9.43^c	18.29^c	26.28^c	6.38^c	12.53^c	23.39^c	30.48^c	9.35^c	16.19^c
Flower extract	13.39^b	16.18^b	6.10^b	11.22^b	20.24^b	28.33^b	8.21^b	14.31^b	25.28^b	33.35^b	10.45^b	18.56^b
Untreated control	16.20^a	18.32^a	8.55^a	12.44^a	26.03^a	33.46^a	10.40^a	17.85^a	28.56^a	38.59^a	13.61^a	20.54^a
SEd	0.48	0.50	0.02	0.05	0.48	0.48	0.48	0.47	0.50	0.009	0.01	0.50
CD (P=0.05)	1.32	1.38	0.06	0.14	1.32	1.32	1.32	1.30	1.39	0.03	0.04	1.40

Each value is mean of four replications

leaf extract over the effect of flower extract, due to reduction of food intake and conversion of food materials.

Biochemical changes due to *C. gigantea* plant parts extract treatment in the body of *E. vigintioctopunctata, H. armigera* and *S. litura* were studied. Results revealed that there was sharp reduction in the major biochemical constituents such as the treatment with *C. gigantea* plant parts *viz.*, leaf and flower. Similar results were obtained by Arul Praksash (2004) who reported that powder of *C. gigantea* plant part had significant effect on the protein, lipid and carbohydrate levels in the body of *C. maculatus, T. castaneum* and *S. oryzae*. Murugesan *et. al.* (2004) also reported, the reduction of biochemical content *viz.*, protein, sugar and lipid due to the combined effect of endosulfan with leaf extract of *Prosopis juliflora* L. on *S. litura*.

The depletion of biochemical content of the treated insect might be related to the heavy utilization of sugar at the time of high energy demands warranted by the altered metabolism due to the residual activity or the dearrangement during the protein metabolism in the treated insect. Moreover the depletion of biochemical composition might be caused by the poor synthesis of stored products and nucleic acids in the larvae, due to the fact that the insect larvae substitute the dietary protein or lipid instead of carbohydrate to meet their energy needs for development from amino acid and fatty acid oxidation (Muthukrishnan *et. al.*, 1979).

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Occurrence of Pest Complex on Cauliflower

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ABSTRACT

A field experiment was conducted to study the occurrence and severity of the pest complex on cauliflower at the Agricultural College Farm, Bapatla during *rabi*, 2003-04. The population count of the pest complex on cauliflower was recorded at weekly interval from a total of 50 plants from five different locations. The months of December and January were favouable for the multiplication of *Spodoptera litura* (Fab.), *Plutella xylostella* (Linn.) and *Lipaphis erysimi* (Kalt.). The peak incidence of *P. xylostella* and *L. erysimi* was recorded during the second week of January while that of *S. litura* during the third week of January.

Key words : Lipaphis erysimi, Plutella xylostella, Spodoptera litura, Cauliflower

Cauliflower (*Brassica oleraceae* var *botrytis* Linn.) is one of the most important vegetable crops of India which is thermosensitive and requires cooler climate. In the world, India ranks first in the production of cauliflower. In India it is cultivated in an area of 0.26 m.ha with a production of 4.80 m.t. (Andhra Pradesh Agricultural Statistics at a glance, 2002). The cultivation of cauliflower is hindered by the incidence of several pests *viz.*, the diamondback moth, *Plutella xylostella* (Linn.), the tobacco caterpillar, *Spodoptera litura* (Fab.) and the mustard aphid, *Lipaphis erysimi* (Kalt.) resulting in significant yield loss (Dhamo and Jotwani, 1984). Among these, the diamondback moth is the most dreaded, devastating and cosmopolitan pest while, *S. litura* is the notorious polyphagous pest. Location specific studies on the seasonal occurrence of different pests of cauliflower provides information on the initiation and extent of damage at different growth stages of the crop and relation with weather parameters which is of great help to plan appropriate management.

MATERIAL AND METHODS

A field investigation was conducted during *rabi*, 2003-04 at the Agricultural College Farm, Bapatla. A bulk plot of 210 m^2 was raised to study the seasonal incidence of pest complex on cauliflower. The pest population was recorded in the unprotected bulk plot of cauliflower at seven days interval coinciding with the initiation of the pest and continued up to maturity. A total of 50 plants from five different locations, ten plants per location, were randomly selected and tagged for taking observations. The number of larvae of different pests per plant were counted at each observation from the selected plants. Aphid population was recorded by three leaf method, selectivity one each from the crown, middle and base of the plant. The meteorological data on maximum and minimum temperatures, morning and evening relative humidities and rainfall were considered for correlating with the incidence of *S. litura, P. xylostella* and *L. erysimi*. The correlation and multiple linear regression analysis was adopted to know the relationship between weather parameters and pest incidence.

RESULTS AND DISCUSSION

The data (Table 1) indicated that the initial occurrence of *S. litura* was during the first week of December, 2003 (2-12-03) *i.e.*, at 14 days after transplantation. The pest population increased gradually from 2-12-03 and reached a peak by 20-1-04 *i.e.*, at 63 days after transplantation with 15.80 larvae per plant. Due to cyclonic effect the pest population decreased during the active growth stage of the crop with 7.6 and 5.6 larvae per plant on 16-12-03 and 30-12-03, respectively. The rainfall recorded during that period was 90.60 mm/week and 56.90 mm/week, respectively. From second fortnight of January the pest load declined gradually with rise in maximum and minimum temperatures recording (9.6 larvae per plant) at 77 days after transplantation by 3-2-04.

Correlation studies between the larval population and the major weather parameters indicated positive but non-significant (r=0.2287) association between the pest load and the maximum temperature while the association between the larval population and the minimum temperature (r=0.7545) was negative and significant (Table 2). The relationship between the larval population and the morning relative humidity (r=0.8232) was positive and significant and the relationship with evening relative humidity

Table 1 : Influence of weather parameters on the incidence of S. litura, P. xylostella and L. erysimi on cauliflower during rabi, 2003-04.

Date of obser-vation	Mean popula-tion of S. litura per plant	Mean popula-tion of P. xylostella per plant	Mean popula-tion of L. erysimi per plant	Temperature (°C)		Relative Humidity (%)		
				Maximum (X_1)	Minimum (X_1)	Morning (X_3)	Evening (X_4)	Rainfall
Dec' 2nd	5.8	2.6	8.8	30.27	19.01	90.71	67.70	--
Dec' 9th	11.2	3.4	12.4	29.92	17.35	92.14	62.30	--
Dec' 16th	7.6	1.8	5.6	28.35	18.25	89.57	73.10	90.60
Dec' 23rd	8.2	2.4	6.2	28.50	17.31	89.80	66.60	--
Dec' 30th	5.6	1.6	5.4	26.30	20.11	91.57	82.10	56.90
Jan' 6th	9.8	6.4	11.8	28.50	17.20	94.14	67.40	--
Jan' 13th	12.6	9.6	16.6	28.50	15.35	96.57	63.80	--
Jan' 20th	15.8	7.8	13.8	28.90	15.05	97.70	68.70	--
Jan' 27th	10.8	6.4	11.6	29.50	19.17	92.00	72.00	--
Feb' 3rd	9.6	5.6	10.8	30.21	20.07	91.40	68.33	--

(r= -0.4879) was negative and non-significant. The relationship between the larval population and the rainfall (r= -0.4621) was negative but non-significant. The results of the present study are in close agreement with the findings of Murthy (1994) who reported negative association between the larval population and the maximum and minimum temperatures and the evening relative humidity and positive relationship with the morning relative humidity. The data on larval incidence when subjected to multiple linear regression analysis (Table 2), the following equation was arrived.

$$Y = -77.9502 + 1.1838\,X_1 - 0.8789\,X_2 + 0.6382X_3 + 0.1454\,X_4 + 0.0003\,X_5$$

Table 2 : Simple correlation and multiple linear regression between weather parameters and incidence of *S. litura* on cauliflower during rabi, 2003-04.

Variable	Weather parameters	Correlation coefficient 'r'	Regression coefficient (b)	Standard error	'r' value
X_1	Maximum temperature	0.2287	1.1838	1.1439	1.0349
X_2	Minimum temperature	-0.7545*	-0.8789	1.0805	0.8134
X_3	Morning R.H	0.8232*	0.6382	0.5177	1.2326
X_4	Evening R.H	-0.4879	0.1454	0.3665	0.3967
X_5	Rainfall	-0.4621	0.0003	0.0378	0.0099

Intercept (a) = -77.9502, per cent of variation attributed to the regression (R^2) = 0.5612865, * Significant at 5% level

The data recorded on the incidence of *P. xylostella* (Table 1) revealed that the initial occurrence of the diamondback moth was during the first week of December, 2003 (2-12-03) *i.e.*, at 14 days after transplantation (2-12-03) with 2.6 larvae per plant. The pest population increased gradually from 2-12-03 and reached peak level by 13-1-04 *i.e.*, at 56 days after transplantation with 9.6 larvae per plant. Due to cyclonic effect the pest population decreased during the active growth stage of the crop similar to that of *S. litura* with 1.8 and 1.6 larvae per plant on 16-12-03 and 30-12-03, respectively. The rainfall recorded during that period was 90.60 mm/week and 56.90 mm/week, respectively. The pest load declined gradually with rise in maximum and minimum temperatures and reached minimum by 3-2-04 (5.6 larvae per plant) *i.e.*, at 77 days after transplantation.

Table 3 :Simple correlation and multiple linear regression between weather parameters and incidence of *P. xylostella* on cauliflower during rabi, 2003-04.

Variable	Weather parameters	Correlation coefficient 'r'	Regression coefficient (b)	Standard error	'r' value
X_1	Maximum temperature	0.2009	0.1206	0.9774	0.1234
X_2	Minimum temperature	-0.5975	0.5274	0.9232	0.5713
X_3	Morning R.H	0.8560*	1.0339	0.4424	2.3370*
X_4	Evening R.H	-0.4324	-0.1460	0.3132	0.4664
X_5	Rainfall	-0.5578	-0.0012	0.0323	0.0371

Intercept (a) = -77.9502, per cent of variation attributed to the regression (R^2) = 0.5612865, * Significant at 5% level.

Correlations were worked to find out the relationship between the larval population of *P xylostella* and the major weather parameters. The results indicated positive but non-significant (r=0.2009) relationship between the pest load and the maximum temperature while the relationship between the larval population and the minimum temperature was negative but non-significant

Table 4 : Simple correlation and multiple linear regression between weather parameters and incidence of *L. erysimi* on cauliflower during *rabi*, 2003-04.

Variable	Weather parameters	Correlation coefficient 'r'	Regression coefficient (b)	Standard error	'r' value
X_1	Maximum temperature	0.3883	0.0624	0.7507	0.0833
X_2	Minimum temperature	-0.6416*	1.0523	0.7084	1.4855
X_3	Morning R.H	0.8252*	1.3900	0.3394	4.0942*
X_4	Evening R.H	-0.6520*	-0.4521	0.2403	1.8810
X_5	Rainfall	-0.6734*	0.0083	0.0248	0.3365

Intercept (a) = -107.762, per cent of variation attributed to the regression (R^2) = 0.8607963, * Significant at 5% level (r= -0.5975) (Table 3). The relationship between the larval population and the morning relative humidity was positive and significant (r=0.8560) while it was negative but non-significant (r= -0.4324) between the pest population and the evening relative humidity. The relationship between the larval population and the rainfall was also negative but non-significant (r=-0.5578). The results of the present study are in agreement with the findings of Soujanya (2003) who reported negative association between the larval population and the maximum and minimum temperatures and the evening relative humidity but positive correlation with the morning relative humidity. The data on larval incidence when subjected to multiple linear regression analysis (Table 3), the following equation was arrived.

$$Y = -93.7391 + 0.1206 X_1 + 0.5274 X_2 + 1.0339 X_3 - 0.1460 X_4 - 0.0012 X_5$$

The data recorded on the incidence of *L. erysimi* (Table 1) revealed that the population of *L. erysimi* was observed from 2-12-03 to 3-2-04. During the initial observation on 2-12-03 *i.e.,* at 14 days after transplantation 8.8 aphids per plant were recorded. The pest population increased gradually from 2-12-03 and reached a peak by 13-1-04 *i.e.* at 56 days after transplantation with 16.6 aphids per plant. Thereafter, the pest population declined gradually with rise in maximum and minimum temperatures recording 10.8 aphids per plant at 77 days after transplantation. Due to cyclonic effect the pest population decreased during the active growth stage of the crop with 5.6 and 5.4 aphids per plant on 16-12-03 and 30-12-03, respectively.

Correlations were worked at to find out the relationship between the aphid population and the weather parameters. The results indicated positive but non-significant (r=0.3883) association between the aphid population and the maximum temperature and the association with the minimum temperature (r= -0.6461) was negative and significant (Table 4). The relationship between the aphid population and the morning relative humidity (r=0.8252) was positive and significant while the relationship with the evening relative humidity (r= -0.6520) was negative and significant. The relationship between the aphid population and the rainfall (r=0.6734) was negative and significant. These results are in accordance with Ahuja (1990) except the relationship with the evening relative humidity. The data on the incidence of aphid when subjected to multiple linear regression analysis (Table 4), the following equation was arrived.

$$Y = -107.762 + 0.0624 X_1 + 1.0523 X_2 + 1.3900 X_3 - 0.4521 X_4 + 0.0083 X_5$$

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Influence of Holding Solution, Dry Refrigeration and Packing Material on Quality and Longevity of Chrysanthemum Flowers

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ABSTRACT

Experiments were conducted to standardize the holding solution, refrigerated dry storage and packing material to improve the vase life of cut flowers of chrysanthemum variety "Basanthi". The crop was grown during *kharif* 2003 and 2004. The stem with flowers were kept in different holding solutions. Sucrose 2% + Dichlorphene 25 ppm or sucrose 2% + citric acid 25 ppm + Ag NO_3 25 ppm significantly improved the vase life compared to their preservation in water. The refrigerated dry storage impaired the vase life and reduced the flower diameter with increase in the period of storage. Polythene sleeves were the best packing material. They increased the vase life and flower diameter consistently during the two years. Packing in cellophane or polypropylene sleeves also increased the vase life of the flowers but they did not improve the flower diameter.

Key words : Chrysanthemum, Holding Solution, Refrigerated Dry Storage, Packing Material, Vase Life, Flower Diameter

Chrysanthemum (*Dendranthema grandiflora*) is an important commercial cut flower of world trade. It is cultivated for making garlands and mostly used in religious ceremonies. It is a highly tempting flower owing to its brilliant colour tones, wide range of shades and size of flowers. It ranks second only after rose (Kher, 1990). The cut flowers are delicate. Inept handling and post-harvest practices lead to considerable losses. They lose considerable quantity of water through the stomata during storage and transport.

Air enters the xylem stream to fill up the gap created due to the loss of water and block the xylem vessels. This hinders the absorption of water and cause stress leading to wilting of leaves and florets. The growth of bacteria and fungi in the vase water also plug the xylem vessels and impede the absorption of water. Maintenance of turgor in the florets and prolonging the longevity is a vital consideration after the harvest of chrysanthemum flowers. The vase solutions are useful to improve the quality of cut flowers. But, this requires standardization for different ecological regions and varieties of the crop. Hence, the present investigation was taken up.

MATERIAL AND METHODS

Chrysanthemum variety "Basanthi" was grown in the *kharif* season during 2003 and 2004 on the vertisol at the Agricultural research Institute, Rajendranagar. The flowers were cut when half open for post-harvest handling to improve their longevity. Three separate experiments were conducted under ambient conditions in the laboratory.

Influence of holding solutions

The leaves from lower one-third portion of the cut stems of chrysanthemum flowers were removed and the stems were kept in water. They were then pre-cooled at 4°C for 6 hours. Then they were preserved in 8 different vase solutions and water. These nine treatments (Table 1) were replicated thrice.

Influence of refrigerated dry storage

The harvested cut flowers of chrysanthemum were pre-cooled at 4°C for about 6 hours. Stems of three flowers were loosely tied with a rubber band. Each such bunch was packed in polypropylene sleeves and stored in the fiber board boxes which were provided with two circular vents on the side walls. There were 5 storage treatments *viz.*, 0, 3, 6, 9 and 12 days. After the storage period, the stems were cut by about 2cm from the lower portion. They were then evaluated for vase life by keeping them in water and in the preservative containing sucrose 2% + citric acid 300 ppm. These 10 treatment combinations were studied in three replications.

Influence of packing material and time of storage

The harvested stems were pre-cooled at 4°C for about 6 hours. They were loosely tied into bundles with three flowers each with a rubber band. The bundles were wrapped in polypropylene sleeves, cellophane sleeves, polyethylene sleeves or unwrapped and packed in card board boxes lined with 2 layers of news paper and having 2 vents on the side walls covering approximately 4% area. These boxes were kept under ambient conditions for 24 and 48 hours. Thus there were 8 treatments. These were run over three replications.

The analysis of variance was done following completely randomized block technique with factorial approach for all the three experiments.

RESULTS AND DISCUSSION

The results on the quality of cut flowers of chrysanthemum as influenced by the holding solutions are presented in Table 1. The vase solution containing sucrose 2% + Dichlorphene 25 ppm was most promising. The vase life of the cut flowers increased significantly compared to their preservation in water consistently during the two years. The vase solution containing sucrose 2% + citric acid 75 ppm + Ag NO_3 25 ppm also increased the vase life significantly compared to water during both the years. None of the vase solutions increased the flower diameter. There were no consistent trends in the absorption of water. Shukla and Kher (1999) reported that the factors responsible for keeping quality of the cut flowers are balance of water uptake and water loss, stem plugging, respiration rate, production of toxic substances and ethylene. The rapid uptake of silver and complexes prevent ethylene induction (Veen, 1979). Citric acid is an acidifying agent. It prevents the blockage of xylem vessels in the cut flower stems (Mohan Ram and Ramanuja Rao (1977). In addition to this the role of sucrose as a substrate for respiration keep the flowers turgid and prolong the longevity (Halevy *et. al.*, 1978).

Table 1 : Effect of holding solutions on keeping quality of chrysanthemum stems.

Holding solution	Vase life (days)		Flower diameter (cm)		Water absorbed per stem (ml)	
	2003	2004	2003	2004	2003	2004
Citric acid 75 ppm + Ag NO_3 25 ppm	7.16	3.08	5.46	4.32	126	55
Al $(SO_4)_3$ 300 ppm	6.91	2.98	5.44	4.29	66	46
Na O Cl 25 ppm	6.78	3.31	5.38	4.55	90	42
Dichlorphene 25 ppm	6.85	3.16	5.59	4.30	85	58
Sucrose 2% + Citric acid 75 ppm + Ag NO_3 25 ppm	7.34	3.68	5.43	4.24	106	63
Sucrose 2% + Al $(SO_4)_3$ 300 ppm	6.72	3.22	5.75	4.44	88	35
Sucrose 2% + Na O Cl 25 ppm	6.30	3.50	5.23	3.93	71	40
Sucrose 2% + Dichlorphene 25 ppm	8.37	3.81	5.98	3.92	77	47
Water	6.90	3.21	5.41	3.25	115	67
SE+	0.11	0.21	0.29	0.30	18	8
CD (P=0.05)	0.23	0.44	NS	NS	39	18

CD = Critical difference, NS = Non-significant.

The refrigerated dry storage of cut flowers of chrysanthemum was not useful. The vase life reduced with increase in the time of storage (Table 2). The vase life of chrysanthemum was 6.1 days in 2003 and 3.21 days in 2004 without dry storage. When stored for 3 days, it reduced significantly to 5.8 and 2.67 days during the corresponding years. It was reduced to 5.5 and 2.18 days by increasing the period of storage to 9 days. Similarly, the diameter of the flower reduced by increasing the period of refrigerated dry storage from 3 to 12 days while the largest diameter was incident in flowers not subjected to dry storage. The holding solution containing 2% sucrose + citric acid 300 ppm prolonged the vase life of the flowers significantly compared to water. The uptake of water by the stems was not significantly altered by the storage treatments or holding solution.

Table 2 : Effect of refrigerated dry storage on keeping quality of cut chrysanthemum stems.

Treatment	Vase life (days)		Flower diameter (cm)		Water absorbed per stem (ml)	
	2003	2004	2003	2004	2003	2004
Storage duration (days)						
0	6.1	3.2	5.03	4.04	82	19
3	5.8	2.7	4.81	3.67	96	23
6	5.6	2.6	4.72	3.86	78	18
9	5.5	2.2	4.71	3.67	70	18
SE+	0.02	0.08	0.04	0.09	12	3
CD	0.03	0.16	0.09	0.19	NS	NS
Preservatives						
Holding solution	6.1	2.8	4.78	3.82	80	18
Water	5.4	2.5	4.80	3.81	84	20
SE+	0.01	0.05	0.02	0.06	5	2
CD	0.03	0.12	NS	NS	NS	NS
Interaction						
SE+	0.05	0.11	0.07	0.13	16	5
CD	NS	NS	NS	NS	NS	NS

CD = Critical difference NS = Non-significant

The packing material had a significant influence on the quality of chrysanthemums (Table 3). The unpacked flowers had longevity of 6 days in 2003 and 2.31 days in 2004. The polythene sleeves were the best packing material.

The flower life increased significantly to 7.5 days in the first year and 2.98 days in the second year. The vase life was also significantly superior to unwrapped flowers by packing them in cellophane or polypropylene sleeves. The diameter of the flowers was also significantly larger by packing the flowers in polythene sleeves during both the years. But, packing of

Table 3 : Effect of packing material and storage period on quality of cut flowers of chrysanthemum.

Treatment	Vase life (days)		Flower diameter (cm)		Water absorbed per stem (ml)	
	2003	2004	2003	2004	2003	2004
Packing material						
Control	6.00	2.31	5.21	3.75	65	31
Polythene sleeves	7.50	2.98	5.63	4.08	62	24
Cellophane sleeves	7.20	2.77	5.22	3.75	68	24
Polypropylene sleeves	6.73	2.87	5.18	3.93	60	18
SE±	0.12	0.18	0.11	0.12	6	5
CD (P=0.05)	0.24	0.39	0.24	0.24	NS	NS
Storage period						
24 hours	5.23	2.42	4.01	3.64	63	26
48 hours	5.51	2.85	4.32	4.11	66	23
SE±	0.70	0.12	0.64	0.11	3	2
CD (P=0.05)	NS	NS	NS	0.23	NS	NS
Interaction						
SE±	0.17	0.25	0.16	0.21	7	6
CD (P=0.05)	NS	NS	NS	0.45	NS	NS

CD = Critical difference NS = Non-significant

chrysanthemums in cellophane or polypropylene sleeves did not show a significant improvement in the flower diameter. The effect of storing the packed material for 24 or 48 hours was similar on vase life and flower diameter. The interactions due to packing material and the time of storage were not significant.

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Effect of Seed Size on Seed Quality in Sunflower

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ABSTRACT

A laboratory experiment was conducted to study the effect of seed size on seed quality in sunflower. The results revealed that bold seed recorded higher germination percentage, root length, shoot length, seedling vigor index, seedling dry matter, oil content and lesser values of imbibition rate and electrical conductivity compared to medium, ungraded and small seed. The cultivars were found to be non-significant for the above parameters.

Key words : Sunflower, Seed Size, Seed Quality, Seedling Vigor Index

Sunflower is known for its wide variation in seed size and this heterogeneity could be observed even within a head. Seed size is one of the important considerations of the present day seed industry. Scientific seed production recognizes the importance of optimum size of seeds for raising any kinds of crops to harvest good quality seeds. There is a great relevance of seed germinability and seed vigor for initial assessment of crop productivity (Roberts, 1972).

A general look into the literature indicated that large seeds give rise to vigorous plants and yield more. But studies on sunflower showed conflicting results, where the reports are in favour of large seeds in some cases (Kumar *et. al.,* 1979 and Patel *et. al.,* 1987) where as no significant differences in oil content and yield was observed due to seed size (Robinson, 1974). As sunflower is gaining importance in our country, the research gaps are being covered slowly. The present investigation was taken up to study the effect of seed size on seed quality in sunflower genotypes.

MATERIAL AND METHODS

A laboratory experiment was conducted at Department of Plant Physiology, S. V. Agricultural College, Tirupati, during *kharif* season of 2005 with factorial randomized block design and replicated thrice. The treatment consists of four seed sizes and two cultivars (EC 68414 and APSH-11). The bulk seed of the two cultivars were graded into four different seed sizes manually and by its test weight. The test weight of bold seed was 7.85 g in EC 68414 and 7.65 g in APSH-11, medium seed was 6.2 g in EC 68414 and 6.08 g in APSH-11, small seed was 3.90 g in EC 68414 and 3.84 g in APSH-11 and ungraded seed was 5.3 g in EC 68414 and 5.2 g in APSH-11. The seed material was obtained from *rabi* 2004 harvested crop. The germination test, root length and shoot length were recorded as per ISTA rules (ISTA, 1985). Seedling vigour index was calculated using the formula given by Abdul Baki and Anderson (1973). The imbibition rate was worked out by soaking 5 g seed from each category in 15 ml of water and waiting at four hourly intervals up to 24 hrs. The imbibition rate was calculated on moisture free basis and expressed in percent of water absorption. The EC of the seed leachate was measured in digital EC meter at 6 hourly intervals till constant reading was obtained and the values were expressed in m.mhos.cm^{-1}. The oil content of the seed was estimated treatment wise in all the replications with the help of NMR analyzer as per the method described by Fick *et. al.* (1974).

RESULTS AND DISCUSSION

Significant differences were observed in germination percentage among the seed sizes and cultivars did not differ significantly for germination percentage (Table 1). The germination percentage was significantly higher in bold seed with 93.40 per cent followed by medium seed with 84.00 per cent while lowest germination percentage was recorded in small seed with 72.30 per cent. This might be due to large seed embryo and higher amount of resource food material in cotyledons. Similar results were reported by Hartzook (1969) in groundnut, Singh and Makne (1985) in sorghum and Patel *et. al.* (1987) in sunflower. The interaction between cultivars and seed sizes was found to be non-significant.

There was significant difference among the seed sizes with respect to root and shoot length and cultivars did not differ significantly for root and shoot length (Table 1). The root and shoot length was increased with increasing seed sizes from small seed to bold seed in both cultivars of EC 68414 and APSH-11. The root length was significantly higher in bold seed with 15.30 cm followed by medium sized seed with 13.25 cm while lowest root length recorded in small seed with 11.90 cm. This might be due to seedling establishment entirely depends upon the size of the cotyledons during the initial stage. Seed serves as the "source" for the early seedling growth. The quantity of resources available to the seedling depends upon the size of the seed. The dry matter depletion from the storage tissue of germinating seed into developing embryo axis was very rapid in large sized seed ultimately resulting in enhanced seedling length. Similar results were reported by Paul (1993) in Mesta and Khare *et. al.* (1996) in soybean.

From the data it was evident that the differences observed among the different seed sizes were significant for dry matter production of seedlings (Table 2). The dry matter was significantly higher in bold seed (1.805 g/plant) followed by medium sized seed (1.245 g/plant). The lowest dry matter was recorded in small seed (0.68 g/plant). This might be due to more food materials present in bold seed produce vigorous seedling there by more dry matter as reported by Sivasubramanyam and Ramakrishnan (1977) in sunflower.

Table 1 : Effect of seed size on germination, root, shoot length and seedling index of sunflower genotypes.

Treatments	Germination (%)			Root length (cm)			Shoot length (cm)			Seedling vigor index		
	EC 68414	APSHI-11	Mean	EC 68414	APSHI-11	Mean	EC 68414	APSHI-11	Mean	EC 68414	APSHI-11	Mean
Bold (S_1)	94.50 (76.44)	92.30 (73.89)	93.40 (75.11)	15.10	15.50	15.30	8.80	8.93	8.87	2258	2254	2256
Medium (S_2)	85.10 (67.29)	83.70 (66.19)	84.40 (66.74)	13.20	13.20	13.25	7.20	7.00	7.10	1744	1690	1717
Small (S_3)	73.20 (58.82)	71.40 (57.67)	72.30 (58.24)	10.00	10.10	10.05	5.91	5.51	5.71	1164	1114	1139
Ungraded (S_4)	81.20 (64.30)	78.40 (62.31)	79.80 (63.29)	11.80	12.00	11.90	6.61	6.58	6.59	1502	1456	1479
Mean	83.50 (66.03)	81.45 (64.52)		12.55	12.70		7.13	7.01		1667	1628	
	V	S	V x S	V	S	V x S	V	S	V x S	V	S	VxS
SEm±	2.38	3.37	4.77	0.95	1.35	1.91	0.75	1.07	1.51	45.53	64.38	91.05
CD at 5%	NS	7.23	NS	NS	2.89	NS	NS	2.29	NS	NS	138.10	NS

Figures in parentheses indicate arcsine transformed values, V = Variety, NS = Non-significant, S= Seed size

Seedling vigour index was significantly higher in bold seed with 2256 followed by medium sized seed with 1717. The lower seedling vigour index was recorded in small seed with 1139. This might be due to higher germination percentage and larger seedling length resulted in higher vigour index of bold seed. The result is in conformity with Jagadesh and Shambulingappa (1983) in sunflower and Borate *et. al.*, 1993 in groundnut. The cultivars and interaction between the seed sizes and cultivars were found to be non-significant for seedling vigour index.

There was significant difference among seed sizes and between cultivars for electrical conductivity and imbibition rate (Table 2). Among the seed sizes, small seed recorded higher EC value of 1.555 m.mhos cm^{-1} followed by ungraded seed (1.195 m.mohos cm^{-1}). The lowest electrical conductivity was recorded in bold seed (1.045 m.mhos. cm^{-1}). This might be due to destructive changes in cellular membrane system resulting in more leakage of organic solutes (free sugars, amino acids and fatty acids). There was highly significant negative correlation between imbibition

Table 2 : Effect of seed size on dry matter production, oil content, EC and imbibition rate in sunflower genotypes.

Treatments	Germination (%)			Root length (cm)			Shoot length (cm)			Seedling vigor index		
	EC 68414	APSHI-11	Mean	EC 68414	APSHI-11	Mean	EC 68414	APSHI-11	Mean	EC 68414	APSHI-11	Mean
Bold (S_1)	1.78	1.83	1.805	41.90	42.93	42.42	1.30	0.79	1.045	56.10	52.40	54.25
Medium (S_2)	1.26	1.23	1.245	39.00	40.50	39.75	1.42	0.81	1.115	58.20	55.80	57.00
Small (S_3)	0.70	0.66	0.680	38.01	38.92	38.47	2.01	1.10	1.555	64.20	60.00	62.10
Ungraded (S_4)	1.17	1.20	1.185	38.80	39.97	39.39	1.52	0.87	1.195	62.70	57.50	60.10
Mean	1.22	1.23		39.43	40.58		1.56	0.89		60.30	56.43	
	V	S	V x S	V	S	V x S	V	S	V x S	V	S	VxS
SEm±	0.094	0.133	0.188	0.99	1.41	1.99	0.039	0.055	0.077	1.52	2.15	3.04
CD at 5%	NS	0.285	NS	NS	3.025	NS	0.084	0.117	0.166	3.26	4.60	NS

CD = Critical diference, V = Variety, NS = Non-significant, S= Seed size rate and seed size. This confirms the superiority of large seeds over that of small seeds with regards to EC and imbibition rate. Conforming to resulting of Sivasubramanyam and Ramakrishnan (1977) in sunflower, imbibition rate showed negative correlation with seed sizes in groundnut. Among the cultivars, APSH-11 recorded less value for EC and imbibition rate compared to EC 68414.

Significant differences were observed in oil content between cultivars and seed sizes and interaction between cultivars and seed sizes were found to be non-significant (Table 2). The kernel from bold seed gave higher yield of oil when compared to kernel from small sized seed in both APSH-11 and EC 68414. This might be due to greater translocation of metabolities into the developing seed and higher fat metabolism in them. Similar increase in oil content with increase in seed size was also observed in sunflower (Kumar *et. al.* 1979) and in groundnut (Sahoo *et. al.* (1988). The results of the present study revealed that bold seed had better performance in respect of the germination percentage, seedling vigour index, seedling dry matter and oil content of seed compared to medium, small and ungraded seeds in sunflower genotypes.

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Journal
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Historical Perspective and Theoretical Orientation of Micro-Watershed Management – A Review

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ABSTRACT

The thrust of Indian Agriculture in the post-green revolution period was enhancing agricultural productivity through sustainable practices. In order to achieve this, the Government of India introduced so many national level schemes on watershed development during last seven five year plans. Some of which are RVP, DPAP, DDP, NAWDPRA etc.

Key words : Micro-Watershed Management

India took many years since 1952 to orient the planning and implementation of soil and water conservation on watershed basis (Tejwani, 1984). Under this watershed development in India under different plan periods, externally sponsored schemes in India, policy support and some of the important concepts used in watershed management are presented.

National schemes on watershed development under five year plans

Various national schemes on watershed development are given below covering the name of the sponsoring agency and implementing agency followed by launching the same in plan period.

Externally supported schemes of watershed management in India

In order to augment the investment and try a number of initiatives external supports have been availed from various sources such as FAO, UNDP, FRG, World Bank, DANIDA, EEC etc. A close look showed that objectives, agencies and basis for planning are not uniform, while this details provide sufficient evidence of convergence in overall objective statement, listing objectives etc.

Policy support for watershed development

India recognized the complex and competitive demand on land, water and forests as the natural resources of the country. The initial / sectoral differences in preservation and development and management of these resources was well known, therefore, being considered often policy support to further application of watershed management. Some of these are High Level Committee on Floods (1957), Conference of Agricultural Ministries of states (1961), Irrigation Commission (1972), National Agricultural Commission (1976), National Flood Commission (1980), National Land Use Policy Outlines (1986), National Water Policy (1987) and National Forest Policy (1988) (Das, 1994).

Some of the important concepts used in watershed management

Watershed

It is the land area from which surface water drains into a single outlet (ICRISAT, 1984). Watershed is a convenient unit in planning for over all development of an area (Singh and Prasad Rao, 1990). Watershed is a small geographical unit and self contained replica of the river system (Dilip Fouzdar, 1999).

Watershed management

Watershed management is the process of guiding and organizing resources used on a watershed to provide desired goods and services without adversely affected land, water and forest resources (Das, 1999). It is the programme that holds the key to solve problems of employment, economy, ecology, export and equity (Seth, 2000).

Integrated watershed management

It is the process of formulating and implementing a course of action involving natural and human resources in a watershed taking into account the said economic and institutional factors operating with in the watershed boundary (MANAGE, 1989).

Watershed development

It is a development intervention aimed at productive and sustainable use of basic natural resources such as land and water which has come long way since the start of the intervention from about half a century (Sarkar, 1999).

List of important plan schemes based on watershed management in India.

Scheme	Launched in plan period	Sponsoring agency	Implementing agency
a. Research Watershed Based	I Plan	Ministry of Agriculture, Government of India	Soil and Water Conservation Division, GOI and ICAR since 1966
b. Adhoc Catchment Treatment Programme in 4 River Valley Projects (RVP's)	II Plan	Ministry of Irrigation / Central Water and Power Commission, Govt of India	Project Authorities, Director of Sedimentation of CWPC and River Valley Projects (RVP's), SWC division.
c. Soil Conservation in the Catchment of Thrteen RVP's	III Plan	Ministry of Agriculture, Government of India.	State department of Forests, Soil Conservation, Agricultural Land Development Corporation, Agriculture and Soil Conservation, Engineering, Horticulture and Forestry etc. SWC and Directorate Sedimentation, CWPC at National level.
d. Drought Prone Area Programme (DPAP)	IV Plan	Ministry of Rural Development Government of India	Department of Soil Conservation, Forests Irrigation, Rural Development etc., and new District Rural Development Organisation (DRDO).
e. Desert Development Programme (DDP)	IV Plan	Ministry of Rural Development Government of India	Department of Soil Conservation, Forests Irrigation, Rural Development etc., and new District Rural Development Organisation (DRDO).
f. Forest Research Watershed	IV Plan	Ministry of Agriculture, Government of India	Forest Research Institute (FRI) Dehradun, Division of Forest at national level.
g. Pilot Projects for Protection of Table and Stabilisation of Ravines Area.	IV Plan	Ministry of Agriculture, Government of India	State Department of Soil Conservation, Forest, Agriculture, Land Development Corporation.
h. Experimental Basin under IHP Programme	IV Plan	CSIR/ministry of Irrigation	CWE, ICAR and SWC Div. at National level.
i. Operational Research Watersheds	IV Plan	Ministry of Agriculture/ ICAR	CSWCRTI, Dehradun
j. Schemes at a, c, d, & e got enlarged	IV Plan	As indicated against each above	
k. Integrated Watershed Management in the Catchment of Flood Prone Rivers (FPR)	V Plan	Ministry of Agriculture, Government of India	State Department of Soil Conservation and Forest etc.
l. Pilot Projects on Rainfed Farming / Dryland Agriculture	VI Plan	Ministry of Agriculture, Government of India	State Department of Agricultrue and Soil Conservation Corporation Division at National level.
m. Environmental Experimental Watershed	VI Plan	Ministry of Agriculture / Ministry of Environment and Forest, Government of India	FRI/ICFRI, Dehradun
n. Soil Conservation and Tree Conservation in Himalayas	VI Plan	Ministry of Agriculture / Ministry of Environment and Forest, Government of India	FRI/ICFRI, Dehradun
o. National Watershed Development Project in Rainfed Areas (NWDPRA)	VI Plan	Ministry of Agriculture	Rainfed farming cell
p. Model Watershed Management	VII Plan	Ministry of Agriculture	Central Soil and Water Conservation Research and Training Institute (CSWCRTI) Dehradun with Rural Development Ministry
q. Integrated Water and Development Projects (IWDP) Scheme	VII Plan	Ministry of Environment and Forest, Government of India	State Departments of Forests, Soil Conservation, Agriculture, NGO's, DRO's, Universities, Research Institutes, NWDB/NAEB at National level.
r. Economic Regeneration / Economic Redevelopment Projects (Research and Development Projects)	VII Plan	Min. of Environment and Forest ICFRE	Universities, Institutes concerned with Environment and Ecology.
s. Watershed Management / Rehabilitating Degraded Waste Land.	VII Plan IV Plan	Sponsored program from NWDB/NAEB, Min. of Envi.& Forest Rural Development.	NGO's and VA's like SPWB, BALF, Development alternatives, ANA Sahib Hazare Tarun Bharat Sangh, Myrada, IFFCO etc.

List of important externally supported projects of watershed management / development in India

S.No.	Scheme	Year	External Agency	Indian Nodal Agency	No. of Watersheds	Area (000'ha)
a	ICP Watershed Management	1980-81	FAO	MOA/SWCD	15	150
b	Dhauladhar Watershed Project HP	Early eighties	FRG	MOA/Forest dept.	--	
c	Himalayan Watershed Management Projects, UP	1984-92	WB	MOA/SWCD/ RFCell	2	247
d	Pilot Project for Watershed Development in Rainfed Areas, A.P., Karnataka, M.P and Maharashtra	1984	WB	MOA/RF Cell	28	347
e	Integrated Watershed Management in Ravinous Area of Chambal Yamuna, UP.	1987	EEC	MOA/SWCD	--	62
f	Hydrological Monitoring Network for Small Watershed Projects in RVP/FPR Catchment	1990	FRG	MOA/SWCD	15	150
g	Comprehensive Watershed Development Project Karnataka, Tamil Nadu and Orissa	1990	DANIDA	MOA/RF Cell	--	113
h	South Bhagirthi Integrated Watershed Management Project	1990	EEC	MOA/RF Cell	--	49
i	Integrated Watershed Development Project (Hills) Haryana, H.P., J&K, Punjab (Kardi Project)	1991	EEC	MOA/RF Cell	--	75
j	Integrated Watershed Development Project (for plains of Gujarat, Orissa and Rajasthan)	1991	EEC	MOA/RF Cell	--	37
k	Bhimatal Project	1991	EEC	MOA/RF Cell	--	22
l	Doon Valley Project, UP.	1993	EEC	MOA/RF Cell	--	172
m	Watershed Development Project for NGO's.	1993	FRG/KFW	MOA/RF Cell	--	64
				TOTAL	60	1498

The findings in the form of review are varied plan schemes, externally supported schemes based on watershed management followed by policy support for watershed development. The programmes like RVP's, DPAP, DDP, FPR, IWDP and NWDPRA were reflecting the findings which strengthens the concept of watershed management. Certain other findings which adds to conceptual frame work of watershed management, include the concepts like watershed, watershed management, watershed development and integrated watershed management.

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Adoption of IPM Practices of Dry Paddy Growers of Maharashtra

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ABSTRACT

Adoption of Integrated Pest Management practices in present study refers to the degree of adoption of package of practices such as cultural and agronomical management, mechanical, biological, chemical and precaution first aid while pesticides usage, helps in maintaining the population density of pest below economic injury level. Majority of respondents (68%) belongs to the medium adoption category.

Key words : IPM, Adoption, Dry Paddy

Global concern about harmful impact of pesticides in the environment made the Government of India recognize the benefit of Integrated Pest Management (IPM) programme during 1985. India also a signatory to the agenda 21 of United Nations Conference on Environment and Development (UNCED) 1972, approved and accepted IPM to reduce the use of pesticides in agriculture.

The IPM programme was initially started in selected crops like rice, cotton and vegetables. The aim of programme is to educate the farmers, extension agency in IPM through various extension methods *viz.*, training, demonstrations and mass media. IPM involves the monitoring of pest incidence, collections of insects with different traps estimating the pest population, and damage by recording visual counts, adoption of IPM practices by farmers in maintaining the population density of pest below the economic injury level. In view of these problems the present study was carried out.

MATERIAL AND METHODS

The study was carried out in Bandara District of Maharashtra State. The Central Integrated Pest Management Centre, Nagpur, Government of India conducted the IPM training-cum-demonstration programmes in rice in collaboration with State Department of Agriculture (M.S.). In each IPM training programme, 30 farmers participated, the IPM programmes were conducted in 10 villages namely, Arjuni, Betala, Borgaon, Dongergam, Gopewada, Lakhni, Mujbi, Murmadi, Ramara and Sawri were selected. From each village, 15 respondents were selected randomly. Thus total study sample comprises 150 respondents. There are a total 34 practices out of which 10 from cultural and agronomical practices, 4 from mechanical, 3 from biological, 11 from chemical method to control the pest and diseases of national importance and 6 from precaution and first aids while pesticides usage. Data were collected with the help of interview schedule and analysed by using A.M.S.D., frequency and percentage.

RESULTS AND DISCUSSION

Date (Table 1) indicated that majority (68.00%) of IPM respondents had medium adoption, followed by low (16.67%) and high (15.33%) of IPM practices of paddy respondents, respectively.

Table 1 : Distribution of respondents according to adoption of IPM practices of paddy.

N=150

Category	Frequency (F)	Percentage (%)
Low (<Mean - SD)	25	16.67
Medium (Mean + SD)	102	68.00
High (>Mean + SD)	23	15.33
Total	150	100.00

Mean = 69.28, S.D=8.31

The result indicated that the majority of respondents had medium adoption. About more than 2/3 of the respondents who form the medium and low adoption category should be target group for extension agencies and efforts should be made to influence these groups for reaching the higher adoption. The finding was in conformity with Sukumar (1972), Devender (1986) and Vekaria *et. al.* (1993).

The adoption of IPM practices such as summer ploughing was adopted fully by 80.66 percentage of respondents, trimming of bunds and destruction of crop residue fully by 84.67 per cent of respondents. The selection of healthy seeds of resistance / tolerant varieties by 74.00 per cent,

Table 2 : Adoption of IPM practices. N=150

IPM Practices	Full adoption		Partial adoption		No adoption	
	Fre quency	%	Fre quency	%	Fre quency	%
A. Cultural and Agronomical management practices						
1. Summer ploughing	121	80.66	10	6.67	19	12.67
2. Training of bunds and destruction of crop residue	127	84.67	23	15.33	-	--
3. Selection of healthy seeds of resistant / tolerant varieties	111	74.00	32	21.33	7	4.67
4. Early and timely planting/sowing	39	26.00	103	68.67	8	5.33
5. Seedling root dip treatment	32	21.00	23	15.33	95	63.34
6. Wider spacing	129	86.00	19	12.67	2	1.33
7. Balanced use of fertilizers	113	75.33	36	24.00	1	0.67
8. Proper water management	118	78.67	32	21.33	--	--
9. Weeding operation / herbicidal application	75	50.00	72	48.00	3	2.00
10. Harvest close to ground level	140	93.33	10	6.67	--	--
B. Mechanical practices						
11. Collection of egg masses, larvae of pest and their placement in bamboo cages cum percher for conservation of biocontrol agents	39	26.00	69	46.00	42	28.00
12. Removal and destruction of disease infected/pest infected plant aprts	57	38.00	85	56.67	8	5.33
13. Installing birds perch stands	41	27.33	75	50.00	34	22.67
14. Pest monitoring	15	10.00	53	35.33	82	54.67
C. Biocontrol practices						
15. Conservation of natural enemies	115	76.67	30	20.00	5	3.33
16. Augmentative release of trichogramma japonicum for lepidopteras pests	14	9.33	38	25.33	98	65.33
17. Observance of pest defender ratio (2:1)	124	82.67	18	12.00	8	5.33
D. Chemical practices (for selected pests)						
18. Gall midge:						
i. Scouting, ETL observation and need based spray of chemical	124	82.67	23	15.33	--	--
ii. Spray of chemicals without seeing ETL.	3	2.0	--	--	--	--
19. Greenleaf hopper						
i. Scouting, ETL observation and need based spray of chemical	115	76.67	34	22.67	--	--
ii. Spray of chemicals without seeing ETL.	--	--	1	0.66	--	--
20. Stem borer						
i. Scouting, ETL observation and need based spray of chemical	133	88.67	9	6.00	--	--
ii. Spray of chemicals without seeing ETL	5	3.33	2	1.33	--	--
21. Leaf folder						
i. Scouting, ETL observation and need based spray of chemical	143	95.33	7	4.67	--	--
ii. Spray of chemicals without seeing ETL.	--	--	--	--	--	--
22. BPH/WBPH						
i. Scouting, ETL observation and need based spray of chemical	138	92.00	12	8.00	--	--
ii. Spray of chemicals without seeing ETL.	--	--	--	--	--	--
23. Hispa						
i. Scouting, ETL observation and need based spray of chemical	125	83.33	25	16.67	--	--
ii. Spray of chemicals without seeing ETL.	--	--	--	--	--	--
24. Earhead bug						
i. Scouting, ETL observation and need based spray of chemical	109	72.67	38	25.33	1	0.6
ii. Spray of chemicals without seeing ETL.	1	0.60	1	0.6	--	--
25. Blast						
i. Scouting, ETL observation and need based spray of chemical	67	44.67	74	49.33	4	2.67
ii. Spray of chemicals without seeing ETL.	2	1.33	2	1.33	1	0.67
26. Sheath blight						
i. Scouting, ETL observation and need based spray of chemical	63	42.00	75	5.00	8	5.33
ii. Spray of chemicals without seeing ETL.	--	--	3	2.00	1	0.66
27. Sheath rot/brown spot						
i. Scouting, ETL observation and need based spray of chemical	73	48.67	68	45.33	6	4.00
ii. Spray of chemicals without seeing ETL.	2	1.33	1	0.67	--	--
28. Rodent						
Mechanical control / used of rodenticide	87	58.00	57	38.00	6	4.00
E. Precautions and first aids while pesticide usage						
29. Storage of pesticide	82	54.67	46	30.67	22	14.66
30. Handling pesticide	100	66.67	48	32.00	2	1.33
31. Precautions for preparing spray solution	123	82.00	27	18.00	--	--
32. Precaution while applying pesticide	123	82.00	27	18.00	--	--
33. Disposal of empty container	98	65.33	38	25.00	14	9.33
34. First aid in case of poisoning	118	78.67	30	20.00	2	1.33

wider spacing (86.00%). Balanced use of fertilizers (75.35%). Early and timely planting / sowing was adopted at partial extent by 68.67% respondents and weed operation / herbicidal application was adopted about 50.00 per cent each at extent at fully and partially. This may be due to the non-availability of labour as well as high labour charges (Table 2).

Among mechanical practices, collection of egg masses, larvae of pest and their placement in bamboo cages were adopted fully by 26.00 per cent, 46.00 per cent partially and 28.00 per cent respondents have not adopted the practice. The practice of removal and destruction of disease infected / pest infected plant part was adopted by 38.00 per cent and by 56.57 per cent fully and partially, respectively. Installing the bird perch stand was adopted fully and partially by 27.33 per cent and 50.00 per cent of respondents respectively. Pest monitoring was adopted fully by 10 per cent respondents and partially by 35.33 per cent of respondents. However, the same practice was not adopted by 54.67% of respondents. This might be due to still they did not understand the importance of mechanical practices. Therefore, efforts may be made by extension agency to motivate farmers for adoption of these practices by educating them.

Among biocontrol practices conservation of natural enemies was adopted fully by 76.67 per cent respondents and by 20.00 per cent of respondents partially. The practice of release of bio-agents was adopted fully by 9.33 per cent followed by 25.33 per cent respondents at partial stage. This practice was not adopted by 65.33 per cent of respondents. Observance of pest defender ratio was adopted fully by 82.67 per cent and partially by 12.00 per cent. It is revealed that 2/3rd of the respondents not adopted of bio-agents practices. This might be due to non-availability or inadequate supply of bioagents in study area. Therefore there is need to establish more biocontrol agents laboratories, thereby adequate bioagents will be supplied as and when required.

Among chemical practices, most of practices were fully adopted by the respondents. In case of some insect and disease, it was partially adopted. This might be due to lack of knowledge of pest and diseases and also difficulty in remembering ETL. Therefore, few more training programmes may be organized for farmers.

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Journal
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Strategic Models for Privatisation of Extension Services in Grape Enterprises

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ABSTRACT

The strategic models were built from the study undertaken at Bijapur district of Karnataka by following ex-post facto research design along with case analyses of KGGA and SS Crop care situated at Bijapur. Typical working modal for privatization of extension service for grape PHTs was developed which called for the integrated operation of private as well as public extension systems for raising the productivity in grape cultivation.

Key words : Privatisation of Extension Service, Grape Enterprises, Strategic Model

It is becoming increasingly evident that public extension by itself can no longer respond to the multifarious demands of farming systems. Public funding for sustaining the vast extension infrastructure is also under considerable strain. In this connection in recent years there has been a trend towards privatization of governmental extension services. Farmers are expected to share the responsibility for this service and pay all or part of costs.

In the fast changing scenario towards privatization of extension services, the crucial issues to be looked into are location of crops and technologies and services with which privatization is possible, farmers opinion towards privatization of extension services and their willingness to pay for it. Considering all these facts, the investigation was undertaken to arrive at suitable models over a paradigm for privatization of extension services in grape enterprises. To that effect a model depicting the privatization of extension services emphasizing the urgent need for exploiting farmers willingness to pay nominal costs for the extension services they receive, was developed by Sureshkumar (1997). Hanchinal (1999) also indicated the significant and non-significant values for association of various independent variables with opinion of farmers on privatization of extension services in grape in an empirical model.

MATERIAL AND METHODS

Ex-post facto research design coupled with case analysis was used since all the variables chosen for the study *viz.*, land holding, innovativeness, achievement motivation, decision making ability, information seeking behaviour, rationality, scientific orientation, economic orientation, marketing orientation, value orientation, management orientation and knowledge on the enterprise have already occurred and can not be manipulated. Bijapur district of Karnataka was selected purposively because of its potential in grape production and productivity. Three taluks from the district Bijapur, Indi and B. Bageewadi were selected following the simple random sampling. Six villages from each taluk were selected randomly with a total of eighteen villages. From each village six farmers were selected randomly constituting the total sample size to one hundred and eight (n=108).

For the case analysis, two organizations namely, Karnataka Grape Growers Association (KGGA) and SS Crop care representing large and small organizations respectively, were selected purposively. Six post-harvest technologies in grape were selected to identify their amicability along with general and preharvest technologies to compare their relative amicability for privatization of extension services. Data were collected by using preteasted structured interview schedule.

RESULTS AND DISCUSSION

The empirical model presented in Figure 1 illustrated the relatinship between independent variables like land holding, innovativeness, achievement, motivation, decision making ability, information seeking behaviour, rationality, scientific orientation, economic orientation, value orientation, marketing orientation, management orientation and knowledge on enterprises. Except land holding, rest of the variables had significant correlation with the farmers' opinion towards privatization of extension services.

In terms of amicability for privatization of extension services for technological services, all the PHT s have shown amicability for privatization

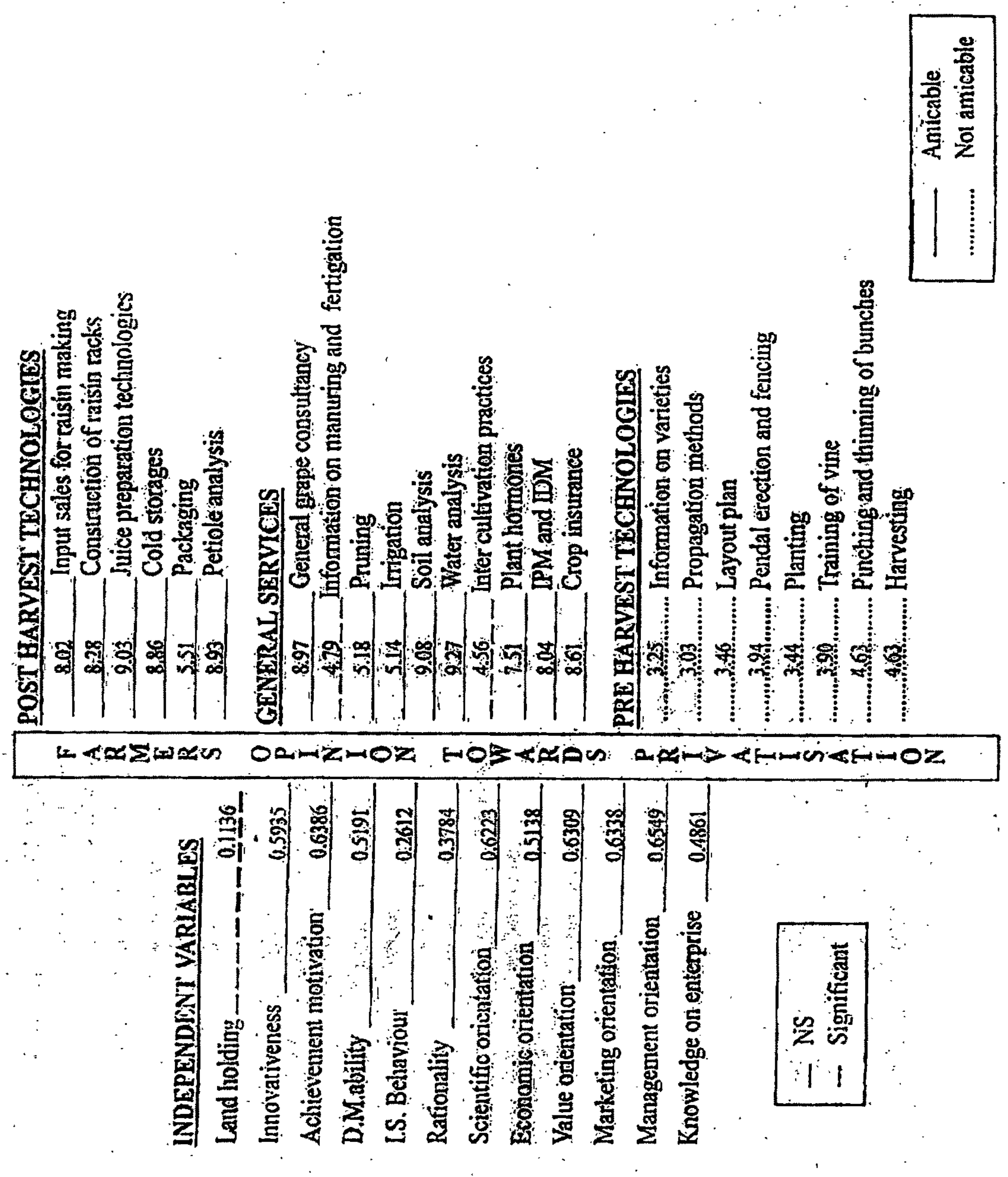
INDEPENDENT VARIABLES
Land holding 0.1136
Innovativeness 0.5935
Achievement motivation 0.6386
D.M.ability 0.5191
I.S. Behaviour 0.2612
Rationality 0.3784
Scientific orientation 0.6223
Economic orientation 0.5138
Value orientation 0.6309
Marketing orientation 0.6338
Management orientation 0.6549
Knowledge on enterprise 0.4861
NS
Significant
FARMERS OPINION TOWARDS PRIVATISATION
POST HARVEST TECHNOLOGIES
8.02 Input sales for raisin making
8.28 Construction of raisin racks
9.03 Juice preparation technologies
8.86 Cold storages
5.51 Packaging
8.93 Petiole analysis
GENERAL SERVICES
8.97 General grape consultancy
4.29 Information on manuring and fertigation
5.18 Pruning
5.14 Irrigation
9.08 Soil analysis
9.27 Water analysis
4.56 Inter cultivation practices
7.51 Plant hormones
8.04 IPM and IDM
8.61 Crop insurance
PRE HARVEST TECHNOLOGIES
3.25 Information on varieties
3.03 Propagation methods
3.46 Layout plan
3.94 Pendal erection and fencing
3.44 Planting
3.90 Training of vine
4.63 Pinching and thinning of bunches
4.63 Harvesting
Amicable
Not amicable

Fig 1:Empirical model for privatisation of extension services in PHTs of grape

and most of the general services were also fund amicable. However, no preharvest technology was deemed amicable for privatization by farmers. The amicability scores were also presented in the empirical model (Fig.1).

The said model draws the attention for increased scope for privatization of extension services in PHTs. In order to sustain the tempo of positive opinion towards privatization, the profile characters of the farmers need to be strengthened for further development.

Amicable technologies identified for privatization required to be served by the private agencies and consultants in a way desired by the framers which help ultimately in increasing their productivity.

Model over a paradigm for privatization of extension services in post-harvest technologies of grape

Based on the present investigation a typical working mdoel over a paradigm for privatization of extension services in post-harvest technologies of grape (Fig.2) was arrived at.

Farmer is at the central point around whom the activities of privatized extension system and public extension system should be oriented. Farmes are interested to be safeguarded by farmers association.

Various input agencies and consultants, need to provide the required inputs and services to the farmers based on his needs and interests

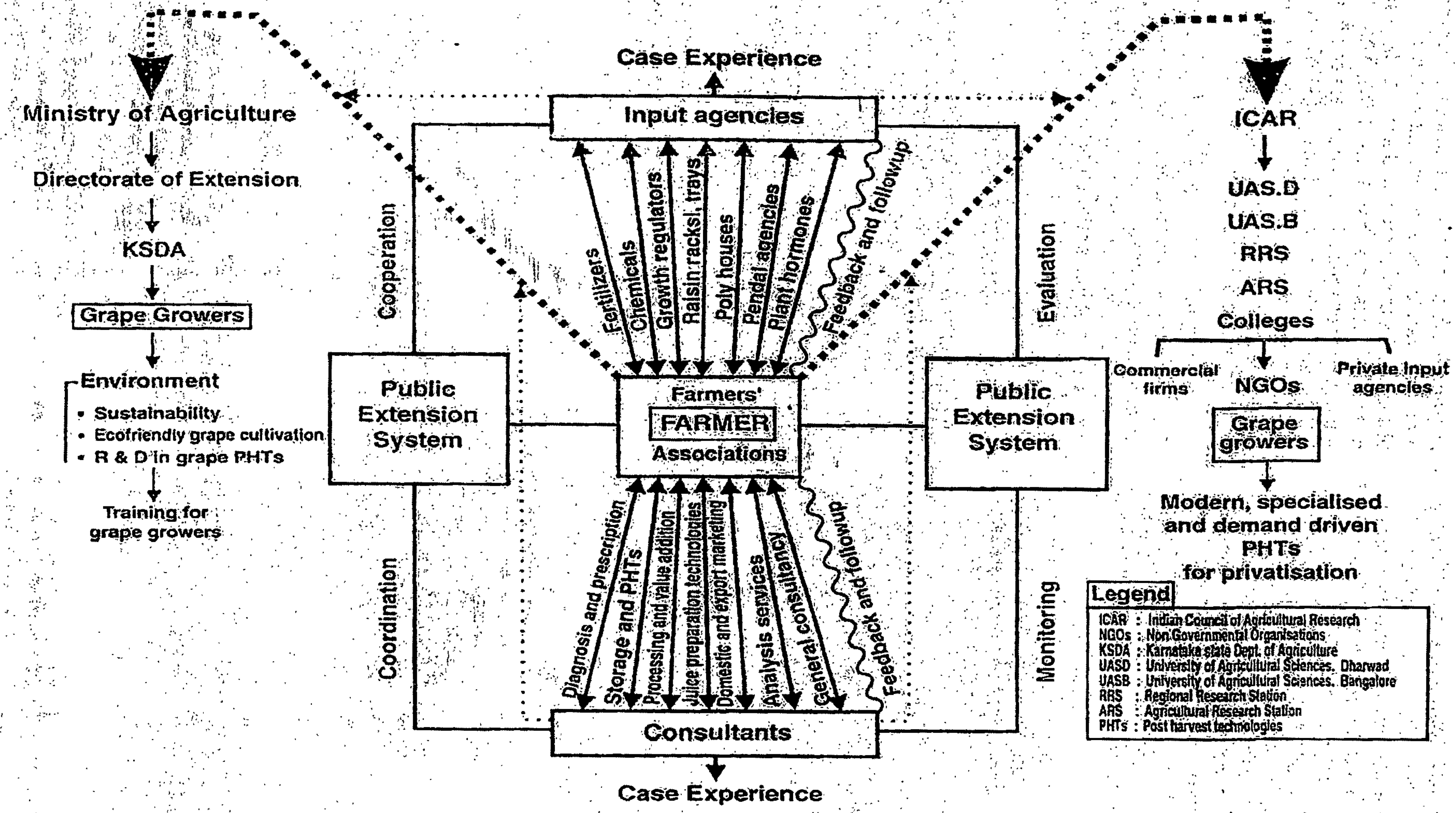
Ministry of Agriculture
Directorate of Extension
KSDA
Grape Growers
Environment
• Sustainability
• Ecofriendly grape cultivation
• R & D in grape PHTs
Training for grape growers
Cooperation
Coordination
Public Extension System
Case Experience
Input agencies
Fertilizers
Chemicals
Growth regulators
Raisin racksl, trays
Poly houses
Pendal agencies
Plant hormones
Feedback and followup
Farmers' FARMER Associations
Diagnosis and prescription
Storage and PHTs
Processing and value addition
Juice preparation technologies
Domestic and export marketing
Analysis services
General consultancy
Feedback and followup
Consultants
Case Experience
Public Extension System
Evaluation
Monitoring
ICAR
UAS.D
UAS.B
RRS
ARS
Colleges
Commercial firms
NGOs
Private input agencies
Grape growers
Modern, specialised and demand driven PHTs for privatisation
Legend
ICAR : Indian Council of Agricultural Research
NGOs : Non Governmental Organisations
KSDA : Karnataka state Dept. of Agriculture
UASD : University of Agricultural Sciences, Dharwad
UASB : University of Agricultural Sciences, Bangalore
RRS : Regional Research Station
ARS : Agricultural Research Station
PHTs : Post harvest technologies

Fig 2: Typical working model for privatisation of extension services for grape PHTs

which must be farmer friendly and eco-friendly. Broad scope was found for input agenecies for the supply of various inputs like fertilizers, chemicals, growth regulators and hormones and raisin racks, trays, polyhouses, pendal inputs etc, which should be of good quality and supplied at reasonable price. Similar kind of wider scope was observed with consultants for various services ike diagnosis and prescription technologies, domestic and export marketing analysis services and general consultancy services. The feed back and follow up should also be rested with private consultants in order to serve the farmers effectively.

Similar kind of observations were obtained in the case illustrations of KGGA (Karnataka Grape Growers Association) and S S Crop care a private consultancy agency situated at Bijapur in the present investigation.

Other than the private extension services, public extension system also need to play a major role in coordination, monitoring and evaluating the services and inputs supplied by private agencies. Public extension system also required to control various policy matters, marketing and financing activities.

From the present study, it was felt that the Ministry of Agriculture and ICAR through their wider operational network not only required to facilitate but also monitor closely, the activities of various extension systems and undertake appropriate research and development activities in grape PHTs and training activities to upgrade grape growers skills and simultaneously aiming at sustainable environment and eco-friendly grape cultivation. It is time that SAUs, RRS, ARS and agricultural colleges along with private agencies, NGOs and commercial firms together move towards facilitating farmers in increasing the production and productivity of grape in high potential areas of grape cultivation.

The model vide Fig.2 work comfortably in Bijapur track – a bowl for grapes, for privatization of extension services of PHTs. However, the model could also be used in other areas not only with similar ethnic and cultural background but also in areas of high potentiality for grape cultivation.

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Sources of Information Utilized by the Women Farmers of Warangal District in Andhra Pradesh

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ABSTRACT

A study was conducted in Warangal district of Andhra Pradesh to identify the sources of information utilized by the women farmers. Majority of the respondents were using neighbours and friends as first source of information followed by personal experience, husband, annadata, television. Majority of the respondents reported to involve in harvesting, weeding, chilli picking, transplanting and cotton picking operations. Further, majority of rural women also expressed the constraints in agriculture *viz.*, electricity problem, high cost of pesticides, non-availability of quality seed material, adulterated pesticides, low market price and lack of finance.

Key words : Sources of Information, Women Farmers

Since time immemorial women have played a significant role in agricultural development and allied fields. Their participation is indispensable for successful development of a country. In India, women contribute about 19 per cent of the total work force and agriculture is the main activity of these women. They take part in farm activities in addition to their multifarious responsibilities in the home front.

Before dissemination of any farm idea or technology to the farmwomen, it is important to find out their existing communication behaviour. Keeping this in view a study was conducted with the objectives to study the personal characteristics of the women farmers and information sources utilized by the women farmers, to know the major works carried out by the women farmers and the constraints in agriculture expressed by the women farmers.

MATERIAL AND METHODS

The study was conducted by using ex-post-facto research design duly following the random sampling procedure in ten villages viz., Komalla, Dasannagudem, Pembarthi, Yerragollapahad, Siripuram, Chituru, Konkapaka, Choutupally, Chennaram, Panthini of five mandals *viz.*, Raghunathapally, Jangaon, Lingala Gahnpur, Parvathagiri, Wardhannapet of Warangal district. A total of 50 respondents (5 farmers from each village) were chosen from the ten selected villages. The data collected with the help of interview schedule were coded, tabulated and analysed.

Six independent variables – age, education, caste, occupation, experience in farming, size of land holding were selected for the study and their relationship with sources of information were worked out.

RESULTS AND DISCUSSION

An overview of Table 1, revealed that majority of the respondents (70.00%) belonged to the age group of <35 years followed by 28.00 per cent in the age group of 36-54 years and 22.00 per cent in the age group of > 55 years.

Table 1 : Distribution of respondents according to their profile.

N=50

Variable	Category	Frequency	Percentage
Age	<35 years	35	70.00
	36-54 years	14	28.00
	>55 years	1	2.00
Education	Illiterate	18	36.00
	Primary	17	34.00
	High school	11	22.00
	Intermediate	3	6.00
	Graduate	1	2.00
Caste	SC/ST	6	12.00
	BC	20	40.00
	FC	24	48.00
Occupation	Farming	5	10.00
	Farming + Agril. Labour	23	46.00
	Farming + Caste occupation	16	32.00
	Farming + Business	4	8.00
	Farming + Service	2	4.00
Experience in farming	Low	6	12.00
	Medium	34	68.00
	High	10	20.00
Size of land holding	<1 ha	12	24.00
	1-2 ha	19	38.00
	> 2 ha	19	38.00

With regard to level of education 36.00 per cent of respondents were illiterates followed by primary education (34.00%), high school (22.00%), intermediate (6.00%) and graduates (2.00%) leaving an indication that the illiterate chunk of farm women needed to be educated through functional literacy programme.

As far as the caste component is concerned majority of the respondent farm women (48.00%) belonged to forward caste followed by backward classes (40.00%) and 12.00 per cent schedule castes and scheduled tribes.

In relation to occupation majority of respondents (46.00%) doing farming + agricultural labour followed by faming + caste occupation (32.00%), farming alone (10.00%), farming + business (8.00%) and farming + service (2.00%).

With regard to experience in farming 68.00 per cent of the respondents had 5-18 years experience followed by >18 years experience (20.00%) and < 4 years experience (12.00%) in farming.

With respect to size of land holding 38.00 per cent of the respondents had 1-2 ha. Followed by >2 ha (38.00%) and 24.00 per cent of respondents had a land holding upto 1 ha.

Source of information utilized by the women farmers

It is evident from the Table 2, that the majority of the respondents (76.00%) were using neighbours and friends as first source of consultancy followed by personal experience (56.00%), husband (44.00%), annadata (40.00%), television (38.00%), agricultural officer (34.00%), radio (32.00%), input dealers (30.00%), private company people (28.00%), newspaper (22.00%), NGOs (20.00%) and training and demonstrations (18.00%).

Table 2 : Distribution of respondents according to their sources of information.

N=50

Source of information	Frequency	Percentage
Neighbours and friends	38	76.00
Personal experience	28	56.00
Husband	22	44.00
Annadata	20	40.00
Television	19	38.00
Agricultural officer	17	34.00
Radio	16	32.00
Input dealers	15	30.00
Private company people	14	28.00
Newspaper	11	22.00
NGOs	10	20.00
Training and demonstrations	9	18.00

Major works carriedout by the women farmers

A perusal of the Table 3 indicates that the rural women were highly involved in most of the farm activities. Ninety per cent of the respondents reported to involve in harvesting, weeding, chilli picking, 88.00 per cent in transplanting, 80.00 per cent in cotton picking, 54.00 per cent in sowing, manure and fertilizer application, 48.00 per cent in water supply for spraying, 44.00 per cent in stem application to cotton, 34.00 per cent in seed treatment, 30.00 per cent nursery pulling, 24.00 per cent in pests and diseases monitoring and control, 16.00 per cent in storage of food grains and pulses. However, their participation was found low in irrigation (10.00%), marketing of produce (8.00%), land preparation (8.00%), threshing (8.00%), spraying operation (4.00%). Leena Das (1995) also reported similar findings.

Table 3 : Major works carried out by women farmers

N=50

Source of information	Frequency	Percentage
Harvesting	45	90.00
Weeding	45	90.00
Chilli picking	45	90.00
Transplanting	44	88.00
Cotton picking	40	80.00
Sowing	27	54.00
Manure and fertilizer application	27	54.00
Water supply for spraying	24	48.00
Stem application to cotton	22	44.00
Seed treatment	17	34.00
Nursery pulling	15	30.00
Pest and diseases monitoring and control	12	24.00
Storage of food grains and pulses	8	16.00
Irrigation	5	10.00
Marketing of produce	4	8.00
Land preparation	4	8.00
Threshing	4	8.00
Spraying operation	2	4.00

Constraints in agriculture expressed by the women farmers

It was observed that rural women expessed the twenty constraints in agriculture (Table 4). Of them six constraints were expressed by the 70.00 to 90.00 per cent of the respondents viz., electricity problem, high cost of pesticies, non-availability of quality seed amterial, adulterated pesticides, low market price and alck of finance.

In addition 28.00 to 68.00 per cent of the respondents expressed the following constraints viz., lack of awareness on correct plant protection measures, labour problem, cotton pest and diseses, fodder shortage, low rainfall and water shortage, low wages for labour, low yields, high

Table 4 : Constraints in agriculture expressed by the women farmers.

N=50

Topic	Frequency	Percentage
Electricity problem	45	90.00
High cost of pesticides	43	86.00
Non-availability of quality seed material	42	84.00
Adulterated pesticides	39	78.00
Low market price	37	74.00
Lack of finance	35	70.00
Lack of awareness on correct plant protection measures	34	68.00
Labour problem	32	64.00
Cotton pest and diseases	29	58.00
Fodder shortage	28	56.00
Low rainfall and water shortage	27	54.00
Low wages for labour	26	52.00
Low yields	22	44.00
High cost of cultivation	22	44.00
Lack of awareness about technical knowledge	18	36.00
Non availability of seed in time	18	36.00
Paddy pest and diseases	16	32.00
Unfavourable weather conditions	14	28.00
Chilli pests and diseases	13	26.00
High feed cost and low marketing of poultry birds	5	10.00

cost of cultivation, lack of awareness about technical knowledge, non-availability of seed in time, paddy pest and diseases, unfavourable weather conditions, chilli pests and diseases, high feed cost and low marketing of poultry birds. Kaushik and Singal (1992) reported similar findings.

An overview of the findings indicated that majority of the farm women belonged to the age group of < 35 years, literate, forward caste, farming + agricultural labour, 5-18 years farming experience, > 2 ha of land holding.

Majority of the respondents were using neighbours and friends as first source of information followed by personal experience, husband, annadata, television, agricultural officer, radio, input dealers, private company people, newspaper, NGOs and training and demonstrations. Majority of the respondents reported to involve in harvesting, weeding, chilli picking and operations.

Further, majority of rural women also expressed the constraints in agriculture viz., electricity problem, high cost of pesticides, non-availability of quality seed material, adulterated pesticides, low market price and lack of finance.

Therefore, the planners and other technical personnel connected to the development departments are required to make use of findings. It is in this context the lady extension workers and home scientists should make the women farmers aware of their role as an active partner in agriculture to motivate them for such programmes.

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Journal
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Adoption Gaps of Technology – A Study on Rice in Krishna Western Delta of Andhra Pradesh

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ABSTRACT

A study was conducted in the Pathareddy Palem drainage pilot area of Andhra Pradesh Water Management Project, Bapatla of Andhra Pradesh, to identify the adoption gaps of rice production technology. The results revealed that the mean percentage of adoption was highest for use of recommended seed rate, weed management. The study also finds that majority of farmers are not adopting recommended spacing, green manuring, integrated nutrient and pest management practices.

Key words : Adoption, Drainage Pilot Area, Extension Gap

India (440.00 lakh ha) has the largest acreage under rice in the world (1506.76 lakh ha), but it ranks second in production next to China in 2003. These two countries accounted for 47.38 per cent of area and 51.53 per cent of production in the world. World production of rice rose from 521.14 m.t. in 1990 to 584.39 m.t. in 2003. The highest productivity of 94.31 q/ha of paddy is reported in Egypt. India ranks quite low in productivity at 30.34 q/ha. On an average, paddy area accounts for nearly 25 per cent of total cropped area in the country. During the reference period, 1961-04 paddy showed significant increasing trend both in terms of area (0.53) and productivity (2.04%) and hence in production (2.58%). During the post-green revolution periods *i.e.*, during 1981-90 and 1991-04, the paddy production was increased mainly due to significant contributions from productivity rather than area under cultivation.

Keeping in view the importance of dissemination of scientific production packages to the farmers, it is thought appropriate by the researchers to identify the important adoption gaps in the production of paddy among the sample farmers in Krishna Western delta.

MATERIAL AND METHODS

Pathareddy Palem drainage pilot area was purposively selected for the study, as Andhra Pradesh Water Management Project, Bapatla is extending all technological interventions to reclaim water logging induced soil salinity status and to restore the agricultural production. As paddy is the only crop cultivated during *kharif* season in the study area, due attention is needed to promote and sustain agricultural production. In this context, identification of adoption gaps of paddy production technology and suggesting the strategies to overcome the same deserves special attention. The study was conducted during 2005-06 by selecting all the farmers (62) in the pilot area and the requisite data were collected by a pre-tested schedule.

RESULTS AND DISCUSSION

Size-wise distribution of land holdings

Size-wise distribution of land holdings was studied, as it highlights both the number and area distributed under different size classes of sample farmers and the details are furnished in Table 1. It is evident from the Table 1 that, the average per capita land holding size of sample farmers is 0.37 ha, while marginal category stood first with 97 per cent of total number of land holdings, followed by small category (3%). Accordingly cultivated area was more among marginal category followed by small category in proportion to number of farmers. This clearly implies that, the execution of the project benefits more number of marginal farmers.

Cropping pattern

The cropping pattern followed by the sample farmers was studied and the details were shown in Table 2. It is evident from the Table 2 that, paddy is the major crop cultivated in *kharif* season by all the sample farmers in both the categories. While, sunhemp is cultivated by 23 and 15 per cent of farmers in pilot and control categories,

Table 1 : Size-wise distribution of land holdings in the selected categories.

		Pilot	
Size-Class	Number	Area (ha)	Per capita (ha)
Marginal (<1.00 ha)	60 (96.78)	20.25 (89.40)	0.33
Small (1.00 to 2.00 ha)	2 (3.22)	2.40 (10.60)	1.20
Large (>2.00 ha)	0 (0.00)	0 (0.00)	0.00
Total	62 (100.00)	22.65 (100.00)	0.37

Note : Figures in parentheses indicate percentage.

respectively, during *rabi* which is meant for green manuring or fodder purpose. Majority of the farmers keep their lands fallow in *rabi* season due to severe problem of soil salinity.

Gaps in adoption of production technology of paddy

Variety

BPT 5204 popularly known as Sambha Mahsuri is the variety grown by all the farmers of the drainage pilot area. Even though it is susceptible to major pests and diseases, all the sample farmers prefer the same in lieu of its quality grain and higher market demand. It is the important research gap to be addressed by the scientific community, taking soil salinity intoconsideration in the pilot area.

Table 2 : Cropping pattern followed by sample farmers in the selected categories.

Systems	*Kharif*	*Rabi*	No. of farmers
Pilot			
System I	Paddy (12.71)	--	39
System II	Paddy (9.94)	Sunhemp (9.94)	23
Control			
System I	Paddy (17.46)	--	31
System II	Paddy (12.51)	Sunhemp (12.51)	15

Note : Figures in parentheses are area under crops (ha).

Seed rate

Nearly 98 per cent of the sample farmers adopted the recommended seed rate in cultivation of rice.

Spacing / maintenance of optimum plant population

All the sample farmers are not maintaining optimum spacing in cultivation of rice as against 33 hills recommended. The plant population in the farmer's fields is quite meagre to a tune of only 18-28 hills per square meter as against 33 hills recommended. Most of the farmers are employing farm labour on contract basis to transplant their crop in the fields. This is mainly responsible for low yields of rice in the study area. This is an important extension gap to be addressed by the scientific community through skill oriented training programmes and exposure visits. In addition to that, some times due to scarcity of labour in peak season labour used to cover larger area by planting at wider spacing in order to get more wage per day, hence the plant population was low as against recommended. To overcome this problem farmers should monitor their fields at the time of transplanting for optimum

Seed treatment

No seed treatment was followed by the sample farmers. This finding is in accordance with that of Kareem and Manhari (2001). This was mainly due to lack of awareness about its importance in minimizing the pest and diseases menace on the initial crop growth. It is another important extension gap to be addressed by organizing awareness campaigns on seed treatment and IPM Practices.

Organic manure

Forty five per cent of the rice growers did not apply farmyard manure while fifty percent had applied fewer doses than recommended (4-5 t/ ac) which may be due to its limited availability and higher cost. The above results are in line with the findings of Pochaiah and Ramesh Kumar Reddy, 1998. This gap should deserve special attention, as in the modern ear of agriculture; use of organic manures in the cultivation of crops is gaining more significance. Hence, the Government should strengthen the linkages among different line departments in improving the production of organic manures and its supply to the farmer beneficiaries.

Green Manuring and zinc

No farmer is involved in practicing green manuring and application of micronutrients to the crop. This is in agreement with the findings of Kareem (2001). Due to late release of canal water, the farmers who were already raised the green manuring crop are unable to incorporate the same in the fields at optimum stage of the crop *i.e.*, 45 days after sowing. Hence, farmers are not interested to grow the green manure crop due to non-availability of irrigation water for incorporation, though they are aware of the importance of the green manuring. Lack of knowledge regarding the importance of green manuring and application of micronutrients is the important reason for this adoption gap.

Application of chemical fertilizers

Regarding urea application, majority of the farmers are practicing recommended dosage both at basal and top dressing levels. But for DAP application, full gap exists with respect to top dressing only, as the farmers are applying higher dosages even though not recommended at top dressing level. Similar findings was reported by Rayappa Reddy (1999). In terms of MOP, 62 per cent of the paddy farmers did not practice basal application. Hence, it is high time to advocate the farmers to strictly adhere to the scientific packages for fertilizers application. The excess use of fertilizers like Urea and DAP escalated the cost of cultivation of rice, thereby affecting the profitability, besides affecting the quality of produce due to increased susceptibility of the crop to pests and diseases.

Weed control

Control of weeds in paddy fields was fully adopted by all the paddy growers.

Irrigation

Due to flooding of irrigation water from one field to other, farmers could not maintain the optimum depth of water at different growth stages of the crop. The farmers need scientific reorientation with regard irrigation water management in the rice, as they tend to apply more water to the crop than the actual requirement.

Plant protection measures

The rice growers did not adopt practices of Integrated Pest Management (IPM). The farmers resorted to indiscriminate use of pesticides during last decade which resulted in resurgence of pests and diseases and also affected the natural enemies. No farmer is involved in practicing bio-fertilizers, bio-control agents, botanical pesticides, application of neem products and pheromone traps. This clearly implies that farmers were not exposed to the utility of integrated pest management practices. The knowledge of IPM through organization of Farmers' Field School on paddy helps to bridge the gap.

The study revealed that no farmer is involved in practicing seed treatment, green manuring, while the adoption of integrated nutrient and pest management practices. It is also revealed that the chemical fertilizers and pesticides are being used by the farmers indiscriminately. So the department of agriculture in collaboration with the scientists of the Acharya N G Ranga Agricultural University should organize Farmers' Field School and Participatory Technology development on Rice and also skill training and field visits to improve skills and knowledge and adoption of the recommended practices. For further improvement of productivity of rice there is an urgent need to evolve fine varieties like BPT 5204 with tolerance to soil salinity, water logging and brown plant hopper.

Table 3 : Item wise adoption of improved production technologies of paddy.

Practice /adoption	Quantity	Number	Frequency
Recommended variety			
Adopted		0	0
Non adopted		62	100.00
Seed rate	20-25 kg	61	98.38
	30 kg	1	1.61
Seed treatment with chemicals			
Not adopted		62	100.00
Maintenance of hill per square meter	18	7	11.29
	19	3	4.83
	20	6	9.67
	25	32	51.61
	30	14	22.58
Application of FYM	6 t/ac	7	11.29
	5	3	4.83
	4	14	22.58
	3	7	11.29
	2	3	4.80
Not adopted		28	45.16
Chemical fertilizers			
Basal application- Urea	25 kg/ac	39	62.90
	50	20	32.25
	75	3	4.83
DAP	25 kg/ac	8	12.90
	50	43	69.35
	75	11	17.74
MOP	25	20	32.25
	50	1	1.61
Not adopted		41	66.12
Top dressing			
Urea	25	12	19.35
	50	44	80.64
	25	13	20.96
DAP	50	35	56.45
	100	11	17.74
20:20.0	50	1	1.61
14:35.14	50	2	3.22
Intercultural operations			
Number weedings	2 times	54	87.09
	3 times	8	12.90
Number of times of application of irrigation water	5 times	6	9.60
	10	26	41.93
	15	20	32.25
	20	9	14.51
	25	1	1.61
Number of times of application of Plant protection measures	4 times	14	22.58
	5	39	62.90
	6	9	14.51
Use of IPM practices			
Biofertilizers			
Pheromone traps			
Botanical epsticides			
Biocontrol agents			
Neem products			
Adopted		0	0
Not adopted		62	100.00

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Economics of Production, Marketing and Storage of Maize in Karminagar District of Andhra Pradesh

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ABSTRACT

This investigation was takenup to study the cost of production of maize on different size group farms, to examine the marketable surplus, marketing channels, marketing costs, marketing margins as well as percentage of share of producer in consumer price.

The study was mainly focused on the traditional maize growing areas of Karimnagar district under well irrigation system. A sample of 180 farmers comprising 60 each from 3 size groups of 0 to 2 hectares, 2 to 4 hectares and 4 and above were selected from 6 villages of 3 mandals under different farming systems and different soils were selected for the study by multi-stage random sampling method.

In maize marketing 3 dominant marketing channels were identified in this area.

Channel I : Producer → Consumer

Channel II :Producer → Village middlemen→ Commission agent→ Wholesaler → Poultry consumer

Channel III:Producer → Wholesaler → Poultry consumer.

The marketing costs were highest in Channel II while the producer's share in consumer rupee was highest in Channel I. In the study of cost and returns of maize production, it came to light that net returns were lowest on large farms while the cost of production per quintal was lowest (Rs.272.4) on small farms in comparison to medium (Rs.289.31) and large farms (Rs.305.60). While the marketable surplus was maximum on large farms (91.1%) and minimum on medium farms (55.5%) and on small farms it is being (62%) of the produce. This reveals the consumption pattern and food habits of farmers of Northern Telangana region.

Among the different storage systems, the storage costs per quintal was highest in case of gunny bags followed by godowns being Rs.35.00 and Rs.35.50, respectively. The lowest storage costs were recorded in case of storage bins which was Rs.18.94 only. The most popular system of storage being used in this area was by using gunny bags (38%).

Key words : Maize, Price Spread, Marketable Surplus, Storage

Maize production and marketing is constrained by varying seasonal and price fluctuations in Northern Telangana region of Andhra Pradesh. It is not only a poultry and cattle feed but also a staple food consumed by majority of marginal and small farmers in this area. Improvement of marketing system would enhance the economic welfare of the both parties of maize producer as well as consumer. Maize being one fo the major and important ingredient in poultry and cattle feed do require a well developed market for providing easy access to consumers who depend on the market for their feed supplies and to farmers who shift from subsistence farming to market oriented production. As the prices of animal and poultry feed are raising during the recent years, the demand for Indian corn has reached new heights as prices of Indian corn were competitive compare to that of United States exporting maize in large scale to Far East Asian countries like Indonesia, Vietnam, South Korea besides Asian countries of Srilanka and Bangladesh.

Lack of processing industries forcing the producer to sell their produce at farm gate itself and no serious efforts were made to process the produce and provide attractive package that will enhance the consumer preference as a result the farmers get raw deal. One kilogram of maize which will fetch just Rs.5 at farm gate can be processed and give an appropriate packaging can generate value addition of Rs.100 per kilogram.

Seasonal instability of grain prices including those of maize crop has been a major concern of our governments as well as the consumers in our developing economies. The poor income classes were most vulnerable to these price fluctuations. The significance of this research paper is based on the importance of maize for producer and consumer in this important maize producing district of Karimnagar in Northern telangana Region of Andhra Pradesh.

The present study was conducted in Karimnagar district of Andhra Pradesh during the year 2002-03 with the main objectives : to work out the costs and returns of maize on sample farms of different size groups under well irrigation, to examine the marketable surplus, marketing costs, marketing margins, producers share in consumers rupee under different channels in marketing of maize and to work out the cost of maize storage under different systems at farmers level.

MATERIAL AND METHODS

The methodology adopted of the present study consists of multi-stage random sampling technique. In district Karimnagar, Huzurabad, Jagtial and Siricilla mandals were selected purposively to represent different farming systems and different soils of the district under which the crop is mainly cultivated under well irrigation. From the selected mandals, list of villages growing maize crop were arranged in descending order according to area grown in top 2 villages. Then from each selected village, a list of maize growing farmers was prepared. Then the farmers were segregated into 3 size groups of 0 to 2 hectares, 2 to 4 hectares, 4 and above hectares. Thus 10 farmers from each size group comprising a total of 180 farmers from 6 villages of 3 mandals were selected for the study.

Local agricultural markets situated near these villages were selected as most of the production was disposed off to these markets. Samples taken to estimate cost of storage of maize under different systems of storage at farm level were the same as taken to work out the cost and returns of maize. The study was conducted by survey method with personal interview from selected respondents for the marketing period of 2002-03 with the help of well structured, pre-tested schedules. Marketing costs and margins were worked out by using the following formula.

Marketing costs

$$TC = C_p + \sum_{i=1}^{n} MC_1$$

Where TC = Total cost of marketing

C_p = Cost incurred by producer in marketing

MC_1 = Marketing costs incurred by the i^th^ trader

Marketing margins

$$A_m = P_m - (P_b + M_c)$$

Where A_m = Margin of middlemen or trader

P_m = Selling price of trader

P_b = Buying price of trader

M_c = Marketing costs borne by the trader

Producer's share in consumer's rupee

$$P = (P_F / P_R) \times 100$$

Where P = Producers share in consumer's rupee

P_F = Price received by the farmer

P_R = Price paid by the consumer

Marketing efficiency

$$Me = \left(\frac{P_F}{T_{c+m}} - 1\right) \times 100$$

Where ME = Marketing efficiency

P_F = Price received by the farmer

T_{c+m} = Total marketing costs including margins of traders

RESULTS AND DISCUSSION

Costs and returns of maize production

Table 1 reveals that per hectare input cost was Rs.12,852 on small farms which was lowest in comparison to Rs.15,169.50 per hectare on large farms. The net returns was found to be higher being Rs.5,451 per hectare on small farms in comparison to Rs.5,023 per hectare on medium farms. The net returns were lowest on large farms being Rs.4,605 per hectare in comparison to small and medium farms and the weighted average being Rs.4,949.40 per hectare. The cost of production per unit was also lowest on small farms (Rs.272.40) in comparison to large farms (Rs.305.60) and medium farms (Rs.289.31).

Table 1: Per hecatare yield, cost and returns on sample farms of different size groups.

Particulars	Size groups (in ha)			Weighted average
	0-2	2-4	Above 4	
Yield (q/ha)				
Main product	35.50	36.75	38.25	37.28
Biproduct	39.75	41.75	43.50	42.19
Value of output (Rs.qtl)				
Main product (*426/q)	15125	15655.50	16294.50	15881.20
Byproduct	3180	3320.00	3480	3375.0
Gross returns	18303	18975.50	19774.50	19256.20
Input cost (Rs./ha)	12852	13952.50	15169.50	14306.30
Net income/ha	5451	5023	4605.00	4949.90
Input:Output Ratio	1:1.424	1:1.360	1:1.303	1:1.345
Cost of production /q (Rs)	272.4	289.31	305.60	293.22

* Harvest price of maize

The input output ratio being 1:1,424 on small farms was higher to medium and large farms, this is evident because of efficient use of available resources in small farms.

Marketable surplus

Table 2 and Fig. indicate that marketable surplus of selected farmers has shown a rising trend with the rise in farm holding size. It was maximum (91.1%) on large farms and large farms and minimum (55.5%) on medium farms and on the small farms being (62.0%) of total production. The lowest marketable surplus on small and medium farms was due to retention of more share of produce for family consumption and to make wage payments in kind form rather than cash as in case of big farmers. It also reveals the consumption pattern and food habits of small and medium farmers in this area.

Table 2: Marketable surplus of maize on different size group of holdings.

Particulars	Size groups (in ha)			Weighted average
	0-2	2-4	Above 4	
Area under maize crop (ha)	49.5	54.68	68.76	0.96
Total production (q)	1757.25 (100.00)	2009.49 (100.0)	2630.07 (100.00)	35.53 (100.0)
Quantity retained for consumption (q)	667.76 (38.0)	894.23 (44.5)	234.08 (8.9)	9.97 (28.09)
Marketable surpuls (q)	1089.49 (62.00)	1115.26 (55.5)	2395.99 (91.10)	25.55 (71.91)

Figures in parntheses denote percentage of their respective values

Marketing channels

The prominent marketing channels observed in the marketing of maize in this district were

Channel I : Producer→ Consumer (Poultry)

Channel II : Producer→ Village middlemen → Commission agent → Wholesaler → Poultry consumer

Channel III: Producer→ Wholesaler→ Poultry consumer.

Price spread

The price spread in marketing of maize was depicted in Table 3. The price spread was only Rs.40 in Channel I in comparison to Rs.125 in Channel II and Rs.75 in Channel III. The price spread in Channel II was highest owing to the fact that in this Channel more number of middlemen were involved in marketing, whereas it was lowest in Channel I because no middlemen were involved in this channel while marketing the produce. It also revealed the fact that even though consumer price was different in different channels the net price received by the producer is more or less same in all three channels.

Table 3 : Price spread in marketing of maize (Rs/q)

Particulars	Channel I	Channel I	Channel III
Price received by the farmer/price paid by the village middlemen	540	510	520
Marketing costs incurred by the farmer	40	--	10
Net price received by the producer	500	510	510
Costs incurred by the trader	--	10	--
Margins of village trader	--	40	--
Price received by village trader/ price paid by commission agent	--	550	--
Margins of commission agent	--	20	--
Price pad by wholesaler/price received by commission agent	--	570	510
Market costs incurred by wholesaler	--	15	15
Margins of wholesaler	--	50	50
Price paid by consumer/price received by wholesaler	540	635	575
Price spread	40	125	75

Marketing costs, margins and efficiency

From the Table 4 it was clear that the channel I has no middlemen between producer and consumer while Channel III has one wholesale dealer and Channel II has 3 middlemen. As the length of marketing channel increased the total costs of marketing also increased. The total marketing costs were highest in Channel II in comparison to other two channels. The cost of marketing was lowest (Rs.40) in Channel I as the producer was directly dealing with the consumer, whereas in Channel II village trader, comission agent and wholesaler merchant were involved in marketing: Hence, the total marketing costs were highest in Channel II (Rs.125) in comparison to other two channels.

The producer's share in consumer rupee was highest in Channel I (92.5%) in comparison to other 2 channels. The marketing efficiency was also highest in Channel I (12.5) as there was lowest marketing cost (Rs.40.0) only in comparison to other 2 channels. The marketing efficiency of Channel III was 7.84 and in Channnel II it being 3.70 only. The marketing costs were

Table 4 : Marketing costs, marketing margins, marketing efficiency and producer's share in consumer rupee (Rs./q)

Particulars	Channel I	Channel I	Channel III
Marketing costs	40	25	75
Marketing margins of traders	--	110	50
Marketing efficiency	12.5	2.70	7.84
Producer's share (in %) to consumer's rupee	92.5	80.31	86.95

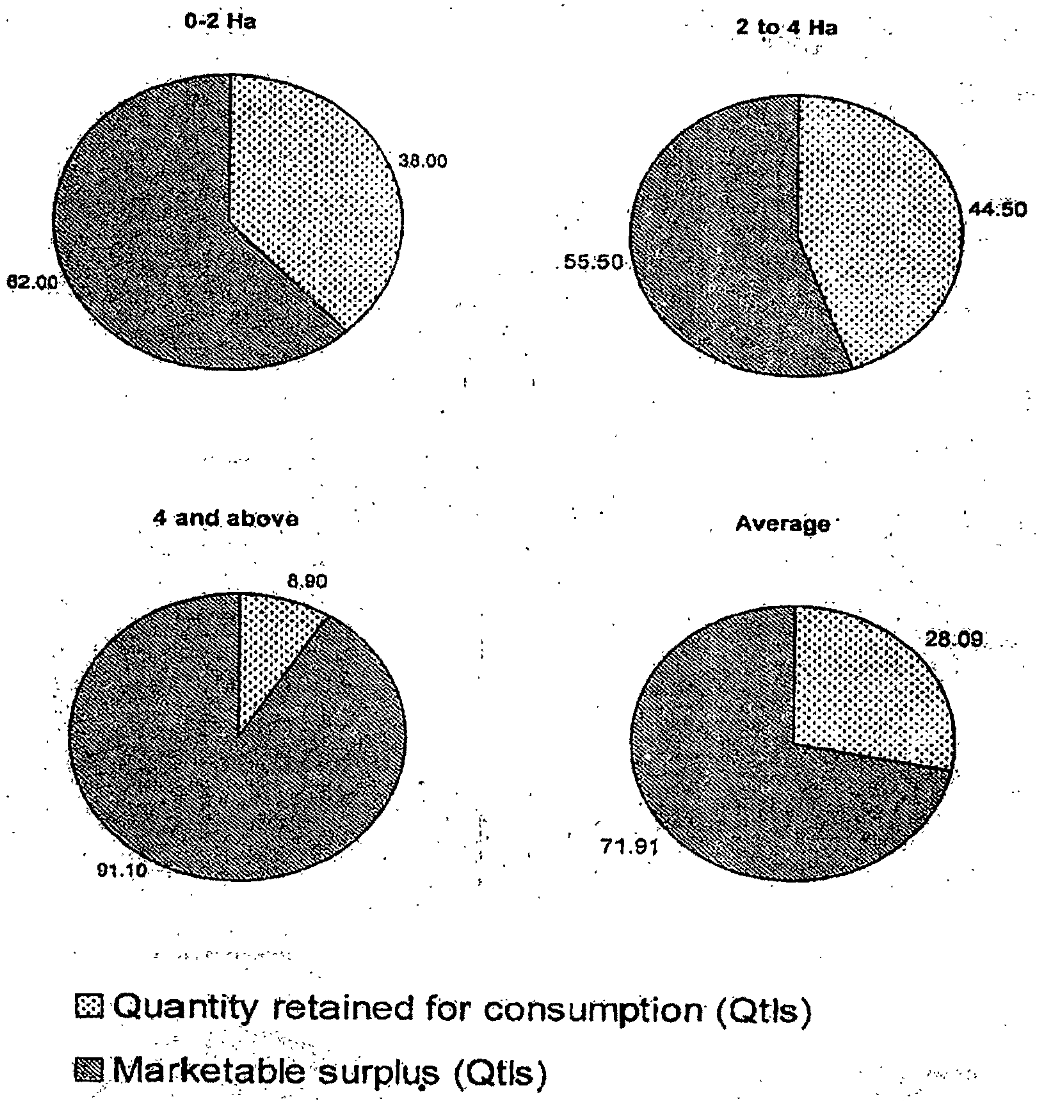

Fig. Marketable surplus of Maize on different size group of holdings

lowest in Channel I as the farmer was directly in contact with the consumer avoiding middlemen in between while marketing his produce.

Storage costs

Table 5 indicates that among different storage systems, bags, open rooms, locally made storage structures, storage bins of steel and small godowns available in rural areas common with farmers under study. The storage cost of maize per quintal per year was different for different systems of storage. It was highest in case of bags followed by godowns being Rs.35.0 and Rs.33.50, respectively. In case of local made storage bins it was Rs.29.25 followed by open rooms Rs.27.22 per quintal. The lowest being steel storage bins which was Rs.18.94 only. The percentage of storage under different storage systems indicated that maximum grain (38%) was stored by using gunny bags while lowest under godown system (4.9%).

Maize being the major crop cultivated in the district of Karimnagar having net income and input-output ratios highest in case of small farms being Rs.5451 and 1:1.424 respectively. While input

Table 5 : Storage costs of maize per quintal per annum (in Rs).

Particulars	Bags	Open room or warandah	Locally made storage bins	Storage bins (steel)	Godown (Rural)
Handling	1.50	1.50	1.50	1.50	1.50
Damage due to rodents	10.50	12.40	0.50	-	-
Loss in weight due to pests	10.00	10.50	9.00	9.00	9.00
Cost of insecticides	0.50	0.50	0.75	0.75	0.75
Depreciation of structure	10.00	0.75	10.00	3.00	10.00
Overhead costs	2.50	1.57	7.50	4.69	12.25
Total cots of storage	35.00	27.22	29.25	18.94	33.50
Percentage under different storage systems	38.00	18.60	33.00	5.50	4.90

cost and cost of production per quintal were highest on large farms being Rs.15,169.5 and Rs.305.6, respectively with input-output ratio of 1:1.303.

A positive correlation was observed in case of marketable surplus and size of holdings. It is clear that increase in marketing costs and margins was observed with increase in length of marketing channel while producer's share in consumers price increased with decrease in length of marketing channel.

The various storage systems popular among the farmers in this area are bags, open rooms, storage bins of different makes and small godowns. Steel storage bins with cost of Rs.18.94 being most economical to store maize grain at farmers level. But most of the farmers use gunny bags (38%) for storage of maize grain compared to other methods of storage.

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Price Spread of Walnut by Different Farm Size Groups in Budgam District of Jammu and Kashmir

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ABSTRACT

A study was conducted in Beerwah block of Budgam district of Jammu and Kashmir. As medium farmers are getting more income per Walnut tree, whereas per hectare net income was observed more on small farm size group. While per quintal cost of production was more on large farm size group respectively. The present study was undertaken during the year 2001-02.

Key words : Walnut, Net Income, Price Spread, Farm Size Group

With the advancements made in the horticulture sector in terms of rapid increase in fruit production like walnut, the dollars earned through exports, the employment generated and the tremendous potential it promise for the future, it is apt to call it as a Golden Revolution. The horticulture sector has given an altogether new dimension in striving towards nutritional security, which covers 6.1 per cent of the country's area. The government has earmarked Rs.1200 crores to horticulture in the IXth plan, assigning top priority to irrigation and water management, food processing and post-harvesting technology through dry fruits like walnut.

The walnut or 'Akhrot' (*Juglaris regia* L.) is under cultivation in temperate region of north India. India is considered as one of the walnut producing countries in the world, producing 8 per cent of total walnut production and ranking 4th in number. During the year 1999-2000 India exported walnut both in sheels as well as kernels of 5,328 metric tonnes valued as rupees 68.92 crores to USA, British, Bangladesh, Sri Lanka, Malaysia, Saudi Arabia and UAE.

The walnut is the important dry fruit of Jammu and Kashmir state. It is grown on an area of 59,428 hectares producing 74,906 metric tonnes annually. In the state walnut provide job opportunities to large number of persons engaged directly (2.27 lakh growers) and indirectly i.e., traders, transporters, labours etc (Anonymous, 2000).

MATERIAL AND METHODS

The present study was undertaken during the year 2001-02. Stratified sampling procedure was adopted for the selection of samples for present study. In the first stage Budgam district was selected purposively. In the second stage Beerwah block was selected randomly. In the third stage villages was selected randomly. A list of walnut growers villages was obtained from the block office and arranged on descending order of hecterage under Walnut trees. Therefore, 10 per cent villages (6 in numbers) were selected by simple random sampling method. A list of walnut growers from each of the village was prepared and they arranged in ascending order on the basis of their number of walnut trees and classified into three categories viz., small (having below 50 walnut trees), medium (having 50-100 walnut trees) and large (above 100 walnut trees).

A sample of 20 per cent sample growers was then drawn by simple random technique from each farm size groups' viz; small (20), medium (20) and large (11) respectively, restricting a sample to 60 farmers. The selected farmer's were contacted by personnel interview method with the help of pre-tested schedules by the investigator.

RESULTS AND DISCUSSION

It is lear from the Table 1 that the average size of holding was 0.98 hectare in first size group and 3.13 hectare in second size group. In third size group average size of holding is 4.70 hectares, the sample average comes to 2.94 hectares. The size of farm increasing means increasing average size holding. Also, the percentage of walnut cultivated area is the highest on large farm size group (38.51) and it is less on small size group (30.61). While the net cultivated area was highest on medium size group (43.86) and lowest on small farm size group (19.91%) respectively. The total area available on different farm size group is 49.61 hectare under walnut cultivation, whereas the average total number of

Table 1 : Average size of holding of growers on different farm size groups (Area in ha).

Category of form size groups	Selected cases	Net cultivated area (ha)	Area under walnut cultivated (ha)	% walnut cultivated area	Average size of holding (ha)	Total number of walnut trees
Small	29 (48.34)	28.42 (19.91)	8.70 (17.54)	30.61	0.98 (11.12)	60
Medium	20 (33.33)	62.60 (43.86)	21.00 (42.33)	33.55	3.13 (35.33)	59
Large	11 (18.33)	51.70 (36.23)	19.91 (40.13)	38.51	4.70 (53.35)	59
Total	60 (100.00)	142.72 (100.00)	49.61 (100.00)	--	8.81 (100.00)	178
Sample average	20 (33.33)	47.57 (33.33)	16.54 (33.33)	34.22	2.94	59.33

Figures in parentheses show percentage

walnut trees ha^{-1} were the highest on small size group (60) and it was lowest on medium and large farm size group (59) respectively.

The Table 2, shows that the net income rupees hectare^{-1} on different farm size groups of walnut was highest (60,618.80). on small group and lowest (52,644.24) on large farm size group. The overall net income was Rs.57,933.31 per hectare. While, the total production of walnut is just reverse, it was highest on large size group (34.45 q ha^{-1}. and lowest on small farm size group 33.73 q ha^{-1}).

The total value of walnut was the highest on medium size group (1,65,273.18 Rs./ha) and the lowest on large size group 1,62,893.96 Rs./ha) it may be due to the retailer's margin on large farm size group. Whereas, the total cost q ha^{-1} is higher on large farm size group (Rs.3,200) and lowest on small farm size group (Rs.3,081) respectively. The total cost per ha is highest on large farm size group (Rs.1,10,249.72) and it is less on small farm size group (Rs.1,03,932.40), while the overall cost was found to be Rs.1,06,306.13. The net income per walnut tree is more on medium farm size group Rs.1,026.05 compared to small (Rs.1,010.31) followed by large farm size group (Rs.892.28) respectively.

Table 2 Net income of walnut by different farm size group.

Farm size	Total production (q/ha)	Value of walnut (Rs./ha)	Total cost of walnut (Rs./ ha)	Cost / q of prod. (Rs)	Net income (Rs./ha)	Net income walnut tree (Rs.)
Small	33.73	164551.20	103932.40	3081.30	60618.80	1010.31
Medium	33.89	165273.18	104736.28	3090.48	60536.90	1026.05
Large	34.45	162893.96	110249.72	3200.28	52644.24	892.28
Overall	34.02	164240.44	106306.13	3124.02	57933.31	976.21

Table 3, shows that the small farm producers share is about Rs.4,878 with 97.56 per cent, while on medium farm size group it was Rs.4,876 with 97.52 per cent followed by large farm size group of Rs.4,728 and the percentage of producer share is 94.56 in the consumer's price. The total cost incurred by small farm is Rs.122 followed by medium farm of Rs.124, which was 2.44 and 2.48 per cent of the total cost respectively. While on large farm size group total cost incurred by the producer, retailer and retailer margin were Rs.123 (2.46%), Rs.81 (1.62%) and Rs.68 (1.36%) respectively. Due to the retailier's intervention (act as intermediate agent) between the producer and consumer on large farm size group. As, consumer has to pay Rs.149 (2.98%) additional of the total cost on large farm size group, which reduced the producer's share in consumer price in comparison to small and medium farm size groups respectively.

As the price paid by consumer is Rs.5000 per quintal on every farm size group, it can be concluded that the average size of farm worked out to be 2.94 ha, the average net cultivated area is 47.53 ha and the area under walnut cultivation per ha is 16.54, which is 34.33 per cent of the total cost. The overall number fo walnut tree is 59.33 per ha on different farm size groups.

The total production was found to be maximum (34.45 q) on large and on small farm size groups it was 33.73 q. Due to more production the total value of walnut was maximum on medium size group (Rs.1,65, 273.18), whereas the total cost per quintal is more on large size group (Rs.3200.28). It may be due to the retailer margin of Rs.149, which is 2.98 per cent of the total cost of consumer price. Therefore, the net income per ha is found to be the least on large size group (Rs.52,644.24), while on small farm size group it was maximum (Rs.60,618.80). The total price paid by consumer is Rs.5,000 per quintal and price received by small farm size group is Rs.4,878 per quintal, which is 97.56 per cent of the total cost, and the cost incurred by producer is Rs.122 (2.44%). Whereas, price

Table 3 : Price spread of walnut by different farm size group (Rs/q).

S.No.	Item of cost	Farm size group		
		Small	Medium	Large
A.	Producer shate	4878.00 (97.56)	4876.00 (97.52)	4728.00 (94.56)
B.	Cost incurred by producer	122.00 (2.44)	124.00 (2.48)	123.00 (2.46)
i.	Transportation charges	13.00 (0.26)	14.00 (0.28)	13.00 (0.26)
ii.	Grading and cleaning charges	72.00 (1.44)	73.00 (1.46)	73.00 (1.46)
iii.	Palledari	3.00 (0.06)	3.00 (0.06)	3.00 (0.06)
iv.	Cost of Bag	30.00 (0.60)	30.00 (0.60)	30.00 (0.60)
v.	Others	4.00 (0.08)	4.00 (0.08)	4.00 (0.08)
C.	Cost incurred by retailer	--	--	81.00 (1.62)
i.	Transportation charges	--	--	26.00 (0.52)
ii.	Packing	--	--	25.00 (0.50)
iii.	Storage	--	--	15.00 (0.30)
iv.	Palledari	--	--	3.00 (0.06)
v.	Taulia	--	--	10.00 (0.20)
vi.	Others	--	--	2.00 (0.40)
D.	Retailers margin	--	--	68.00 (1.36)
E.	Price paid by consumer (A+B+C+D+=E)	5000.00 (100.00)	5000.00 (100.00)	5000.00 (100.00)

Figures in paranthses indicate percentages.

received by the large farm size group is Rs.4,728 per quintal, which is 94.56 per cent of the total cost due to cost incurred by producer is 2.46 per cent (Rs.123), cost incurred by retailer is Rs.81 (1.62%) and its margin is of Rs.68 (1.32%) respectively.

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Research Note

Estimation of Genetic Variability in F_2 Population of Sunflower (*Helianthus annuus* L.)

Key Words: Sunflower, Variability, Heritability, Genetic Advance

Large scale cultivation of sunflower in India began in 1972 with the production of open pollinated variety from USSR origin namely VNIMIK 8931 (EC 664131), PEREDOVIC (EC 68414), ARMAVIRSKIY 3497 (EC 68415) and ARMAVERTS (EC 69874). Of them two varieties namely EC 68414 and EC 68415 are still in cultivation in many stages. During the last decades the area and production of sunflower in India has increased 17 and 15 fold respectively from 1970-71 to 1998-1999. The success of any breeding programme depends on the presence of significant genetic variability to permit effective selection. Therefore, present investigation was undertaken to assess different parameters of genetic variability for six characters.

The experimental material comprised three F_2 crosses i.e. PI 307942 X GP270, CO 3 X GP270 and CO 3 X TNHP2, of sunflower. The experimental material was laid out in a randomized block design with two replications at experimental farm of Department of Oil Seeds, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during December 2001. Each cross was sown in a row of three meter length with inter- and intra-row spacing of 60 cm x 30 cm. Two seeds were dibbled per hill and they were later thinned to one seedling per hill on tenth day after sowing. All the standard agronomic and plant protection measures were followed. At the time of maturity, the data were recorded on the hundred random plants in each replication for six morphological characters namely plant height, head diameter, stem girth, hundred seed weight, seed yield and oil content. Mean values for different characters were used for statistical analysis. The phenotypic (PCV) and genotypic (GCV) coefficients of variability were computed as per Burton (1951), heritability as per Lush (1940) and genetic advance as per Johnson *et. al.* (1955).

In general, the phenotypic coefficients of variability (PCV) were much higher than the corresponding genotypic coefficients of variability for various characters (Table), indicating the marked influence of environment in the expression of these characters. High estimates for both phenotypic coefficients of variability (PCV) and genotypic coefficients of variability (GCV) were obtained for hundred seed weight in PI 307942 x GP 270 (Gangappa, 1991; Kshirasagar *et. al.*, 1995).

High estimates of heritability in broad sense, were recorded for hundred seed weight in all F_2 crosses and seed yield in CO 3 x GP 270 and CO 3 x TNHP2. However, other characters exhibited moderate to low estimates of heritability indicating that these characters are more influenced by environment and, therefore, selection may not be useful in predicting the breeding value of any trait (Johnson *et. al.*, 1955). High estimates of heritability coupled with high genetic advance were obtained for seed yield in CO 3 x GP 270 and CO 3 x TNHP 2. This character was governed by additive gene action and therefore, could be improved by selection. Similar findings have also been reported by Shinde *et. al.* (1983), Muhammed *et. al.* (1992), Irenepriyadarshini (1999) and Sasikala (2000).

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Table : Estimation of mean, range, phenotypic and genotypic coefficient of variabiliity, heritability and genetic advance in sunflower.

Character	Cross	Mean ± S.E	Range	PCV	GCV	Heritability (%)	Genetic advance % of mean
Plant height	PI 307942XGP270	144.31±1.43	110.00-190.00	13.97	4.16	8.85	2.55
	CO3 X GP270	159.69±2.23	55.6-275.00	19.77	8.58	18.86	7.68
	CO3XTNHP2	157.58±1.73	105.00-225.00	15.56	3.21	4.25	1.36
Head diameter	PI 307942XGP270	12.61±0.16	6.70-17.40	17.48	13.55	60.08	21.57
	CO3 X GP270	13.64±0.14	8.70-17.20	14.37	10.62	54.69	16.64
	CO3XTNHP2	14.76±0.13	11.60-18.70	12.75	8.68	46.33	12.06
Stem girth	PI 307942XGP270	6.38±0.10	2.40-9.40	21.83	13.30	37.11	16.61
	CO3 X GP270	6.07±0.11	3.10-8.90	25.79	18.05	48.98	26.03
	CO3XTNHP2	7.08±0.09	3.20-9.50	18.52	7.86	18.02	6.88
Hundred seed weight	PI 307942XGP270	8.02±0.06	4.30-9.80	54.02	53.78	76.09	16.21
	CO3 X GP270	8.12±0.05	6.43-10.20	8.62	7.29	71.43	12.56
	CO3XTNHP2	10.61±0.08	8.47-12.67	10.66	10.45	96.09	21.11
Seed yield per plant	PI 307942XGP270	51.70±0.31	40.30-60.70	8.38	6.25	55.57	9.59
	CO3 X GP270	56.35±0.57	40.20-71.20	14.21	13.19	86.19	25.20
	CO3XTNHP2	97.91±1.13	80.30-125.80	16.30	15.66	2.25	30.98
Oil content	PI 307942XGP270	34.32±0.12	30.68-38.47	4.79	3.22	45.19	4.46
	CO3 X GP270	34.98±0.11	31.43-38.32	4.33	0.83	3.71	0.34
	CO3XTNHP2	34.98±0.13	31.47-39.47	5.07	3.19	39.62	4.13

PCV = Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation

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Research Note

Genetic Variability in Sesame (*Sesamum indicum* L.)

Key Words: Sesame, Heritability, Genetic Advance

Sesame is one of the important oil seed crops grown for its rich source of oil. The oil is rich in vitamin "E" and antioxidants "Sesamin" and "Sesamolin", that prevent oxidative rancidity and increase the shelf life. But the yields are low (300 kg ha^{-1}) and there is need to develop high yielding varities. Variability is quite important to select appropriate parents for hybridization for developing high yielding varieties. Johnson *et. al.* (1995) reported that high heritability estimates give useful indication of relative values of selection based on the phenotypic expression. Heritability values along with genetic gain need to be considered to arrive at a more reliable conclusion. Therefore, 72 sesame lines were tested for variability, heritability and genetic advance.

Seventy two sesame genotypes were studied at Agricultural Research Station, Yellamanchili (ANGRAU) Visakhapatnam, Andhra Pradesh. The lines were tested in randomised block design with two replications. Each entry was sown in a single row of 6 meter length adopting inter- and intra-row spacing of 30 x 15 cm. The recommended package of practices were followed. Data were recorded for seven characters viz., days to 50% flowering, days to maturity, plant height, number of branches per plant, number of capsules per plant, 1000 seed weight and seed yield per plant. Phenotypic and genotypic coefficients of variation were computed according to Burton (1952). Heritability in broad sense was estimated as per Allard (1960) and genetic advance as per Lush (1949) and Johnson *et. al.* (1955).

The analysis of variance showed significant difference among the genotype for all characters. The genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic advance as per cent mean are presented in Table. High heritability and high genetic advance were recorded for plant height, capsules per plant and 1000 seed weight indicating additive gene action in the inheritance of these characters. Bhele *et. al.* (1987) also reported additive gene effects in plant height and 1000 seed weight, while Baruah and Goud (1993) observed similar results for number of capsules per plant. Hence, simple selection is effective for the improvement of these characters.

However for days to 50% flowering, days to maturity, number of branches per plant and seed yield per plant, high heritability and low genetic advance were observed indicating non-additive gene action. Therefore, selecting superior lines and effecting biparental crossing followed by recurrent selection is effective for the improvement of these characters, as also reported by Kandaswamy *et. al.* (1990) for days to 50% flowering and Shadhakshari *et. al.* (1995) for days to maturity. However, Shadhakshari *et. al.* (1995) for number of branches per plant while, Baruah and Goud (1993) for seed yield per plant observed additive gene effects controlling the characters, may be due to difference in genetic material studied.

Table : Estimation of genetic variability parameters for yield component attributes in sesame genotypes.

Character	Genotypic efficient of variation	Phenotypic efficient of variation	Heritability (broad sense)	Genetic advance	Genetic advance as % of mean
Days to 50% flowering	5.50	6.16	79.60	4.16	10.12
Days to matury	5.50	5.63	95.30	9.62	11.05
Plant height	10.37	10.77	92.72	26.94	20.56
Branches per plant	22.12	23.32	89.94	2.19	43.21
Capsules per plant	37.16	37.93	95.97	30.96	74.99
1000 seed weight	7.52	7.72	95.02	53.15	15.09
seed yield per plant	42.08	43.17	95.00	2.93	84.48

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Research Note

Nature of Gene Action for Quantitative Traits in Biparental Progenies of the Cross DCBI 799 X Gowri in Sesame

Key Words: Sesame, Gene Action, Biparental Progenies

In autogamous crops like sesame conventional breeding procedures are generally employed for the development of improved cultures. However, these procedures are inadequate to exploit the full genetic variability for seed yield for the reason that there is restriction on genetic recombination as a consequence of selfing (Srivastava *et. al.,* 1989) and leads to rapid fixation of linked genes, precludes a free exchange of favourable genes and greatly prevents the emergence of gene constellations. Thus, in the conventional breeding procedures like hybridization followed by selection, the genetic variability is locked up due to undesirable linkages and leads to rapid fixation of genes.

The assay of variability upon which a breeder has to exercise his selection is limited in the early segregating generations. As such, it is essential to uncover the latent genetic variability and break undesirable linkages in the early segregating generations. Several investigations have advocated biparental mating in F_2 generation as a measure to achieve above objectives. As such, a study was under taken to work out the nature of gene action in the biparental progeny of the cross DCB 1799 X Gowri in sesame during *kharif,* 2002, wherein, 6 randomly selected females were crossed to 4 males in F_2 generation (Comstock and Robinson, 1952; in NC II design) and two sets of biparental progenies along with F_3 bulk and parents were raised in a randomized block design with 2 replications. Each biparental progeny was represented by 2 rows of 4 m length spaced 30 cm apart. Data were recorded on 10 random, normal looking and competitive plants on 12 quantitative traits viz., plant height, days to maturity, numbr of primary branches, capsules on main stem, capsules on primary branches, capsules per plant, capsule length, seed per capsule, 1000 seed weight, biological yield, harvest index and seed yield per plant and analyzed for North Carolina design II and the magnitude of additive genetic variance ($\sigma^2 A$) and dominance variance (σ^2 D) were computed and furnished in Table.

Seed yield per plant and yield attributes such as number of primary branches, seeds per capsule, 1000 seed weight, biological yield and harvest index registered the supremacy of dominance variance while preponderance of

Table 1: Nature of gene action in the biparental progeles for 12 quantitative traits in sesame.

Character	DCB 1799 X Gowri IBIPII	
	Additive variance	Dominance variance
Plant height	146.10	66.85
Days to maturity	0.64	2.59
N. of primary branches	0.159	0.23
Capsules on main stem	317.51	210.87
Capsules on primary branches	118.79	65.36
Capsules per plant	1248.80	546.55
Capsule length	0.056	0.16
Seeds per capsule	-1.05	53.11
1000 seed weight	0.136	0.172
Biological yield	36.07	69.18
Harvest index	2.78	15.45
Seed yield per plant	1.91	2.25

additive genetic variance for the traits plant height, capsules on main stem, capsules on primary branches (Sudharani *et. al.*, 1997) advocate the importance of additive gene action for these traits and simple selection in future generations would be dependable. While importance of dominance variance for the traits yield, number of primary branches, seed per capsule, 1000 seed weight etc., indicated that these traits can be exploited by recurrent selection.

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Research Note

Evaluation of Onion Cultivars for Late *Rabi* Season Under Krishna - Godavari Zone of Andhra Pradesh

Key Words: Krishna-Godavari Zone, Late *rabi*, Onion Cultivars

Onion as a vegetable spice forms an important constituent diet for large section of Indian population. India commands an area of 3.84 lakh hectares under onion with a production of 40.58 lakh tonnes and occupies second place in the world next to China (Pandey and Srivastava, 1997). It is under commercial cultivation in an area of 27, 105 ha in different agro-climatic zones of Andhra Pradesh (Vijaya, 2004). The Krishna-Godavari zone with more than 4000 ha under onion is one of the important onion growing zones of the state. In this zone onion is mostly grown as a late *kharif* crop in clayey soils which is frequently damaged by heavy cyclonic rains in the month of November. Keeping in view, the problem in onion culture as late *kharif* crop, an effort was made to identify high yielding varieties suitable for this zone during late *rabi* season.

The trial was conducted at Regional Agricultural Research Station, Lam during second week of December, 2000. The soil of the experimental site was clayey in texture and is fertile (180 kg N, 34 kg available P_2O_5 and 470 kg K_2O per hectare). Eight high yielding varieties of onion developed at various Research Institutes were tested with Nasik Red, a popular variety in this zone as check in a randomized block design and replicated thrice. Eight weeks old healthy seedlings were transplanted at inter – and intra – row spacing of 20 x 10 cm in plots of 3 x 1.2 m size during the second week of December. Recommended package of practices were followed (Reddy, 1999). The observations in respect of plant height, number of leaves per plant, polar and equatorial diameters of bulbs, neck thickness and weight of bulb were recorded. The bulb yield was accounted on plot basis.

The data in Table indicated that there were significant differences among the cultivars tested in respect of plant height, number of leaves, polar and equatorial diameter of bulb, neck thickness, weight of bulb and bulb yield. The variety, Arka Niketan produced the tallest crop of 69.7 cm height closely followed by Arka Kalyan with 68.1 cm which in turn were significantly superior over check, Nasik Red (58.7 cm). Contrary to this finding Mohanthy and Prusti (2000) observed Naski red to be the tallest during *kharif* season. The other varieties except Pusa Red were on par with check, Naik Red. The shortest crop of 49.4 cm was observed in Pusa Red. The number of leaves were maximum in Arka Niketan (18.5) which did not differ significantly with Arka Kalyan (18.2). Similar results in case of Arka Kalyan as *kharif* crop were reported by Mohanthy and Prusti (2000). The cultivar, Pusa Red produced lowest number of leaves.

Polar and equatorial dimaters of bulb were significantly highest in Arka Niketan while the other varieties were on par with check in respect of polar and equatorial diameter. The cultivar, Agrifound Dark Red produced bulbs with closest neck of 0.97 cm closely followed by Arka Kalyan with 1.02 cm while Agrifound Light Red produced bulbs with widest neck of 1.34 cm. The thin neck trait of Agrifound Dark red and Arka Kalyan was ascertained to their potentiality for extended storage life (Patil *et. al.*, 1987). Greatest bulb weight of 103 g was recorded in Arka Niketan which was on par with Arka Kalyan (98 g). While other varieties were on par with check, Nasik Red.

Among all the cultivars, Arka Niketan with tallest plants, maximum leaves, highest polar and equatorial diameters and with greatest bulb weight recorded highest bulb yield of 338.2 quintals ha^{-1} followed by Arka Kalyan with 321.3 quintals ha^{-1} which in turn were significantly superior over check, Nasik Red (266.5 q ha^{-1}), in agreement with Gurjar and Singhania (2006), Mohanthy and Das (2000) and Vadivel *et. al.* (1981).

It can be concluded that Arka Niketan with superior plant and bulb characters was found promising for late *rabi* season under Krishna-Godavari agro climatic conditions followed by Ark Kalyan.

Table : Performance of onion cultivars during late *rabi* season.

Name of the cultivar	Plant height (cm)	No. of leaves per plant	Polar diameter (cm)	Equatorial diameter (cm)	Neck thickness (cm)	Bulb weight (g)	Bulb yield (q/ha)
Agrofound dark red	65.9	16.4	5.8	5.7	0.97	92.20	306.4
Agrifound light red	54.2	12.8	5.9	5.0	1.34	76.30	257.6
Arka Niketan	69.7	18.5	6.1	6.2	1.12	103.20	338.2
Arka Kalyan	68.1	18.2	5.9	6.0	1.02	98.40	321.3
Arka Pragati	65.8	16.2	6.2	5.6	1.09	91.50	304.3
N-53	59.6	14.2	5.2	6.0	1.07	83.60	276.6
Pusa Red	49.4	9.3	5.4	4.9	1.08	66.30	219.4
Nasik Red (check)	58.7	13.8	5.4	5.6	1.16	81.00	266.5
CD (0.05)	7.72	4.34	0.58	0.47	0.13	14.31	43.64

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Research Note

Studies on Breaking Seed Dormancy of *Vicia sativa*

Key words: Seed Dormancy, *Vicia sativa*

Vicia sativa is a weed in rice fallow blackgram spreading vigorously in recent years in Krishna-Godavari and North Coastal Zones of Andhra Pradesh. This weed not only compete for moisture and nutrients with blackgram but also adds its seed with blackgram being similar in size and shape, fetching lower rates to the farmers and also reaching distant places along with blackgram when used as seed. It belongs to the family leguminosae and possess seed coat imposed dormancy. Seed coat impermeability is very common in legumes. The dormancy mechanism which prevents water movement through the seed coat is known as impermeability which is distinct from other forms of dormancies inherent in the seed, like post harvest physiological or embryo dormancy (Quinlivan, 1971).

Table 1 : Effect of various treatments on germination percentage of Vicia sativa.

Treatment	Germination %	Transformed values
T_1 : Presoaking with normal water for 12 h	15.0	(22.8)
T_2 : Presoaking with normal water for 24 h	12.0	(20.3)
T_3 : Presoaking with normal water for 36 h	8.0	(16.4)
T_4 : Mechanical scarification for 30 min (Rubbing seeds with sand paper)	45.5	(42.1)
T_5 : Chemical scarification with concentrated H_2SO_4 for 1 min	50.0	(45.0)
T_6 : Chemical scarification with concentrated H_2SO_4 for 3 min	56.7	(49.0)
T_7 : Chemical scarification with concentrated H_2SO_4 for 5 min	69.5	(56.2)
T_8 : Chemical scarification with concentrated H_2SO_4 for 7 min	83.5	(65.6)
T_{11} : Chemical scarification with concentrated H_2SO_4 for 9 min	84.0	(66.4)
T_{10} : Chemical scarification with concentrated H_2SO_4 for 11 min	89.5	(70.6)
T_{11} : Chemical scarification with concentrated H_2SO_4 for 13 min	89.0	(70.6)
T_{12} : Chemical scarification with concentrated H_2SO_4 for 15 min	93.4	(74.6)
T_{13} : Chemical scarification with concentrated H_2SO_4 for 17 min	93.0	(74.7)
T_{14}: Hot water treatment at 50°C for 10 min	9.5	(17.5)
T_{15}: Hot water treatment at 50°C for 20 min	8.0	(16.4)
T_{16}: Hot water treatment at 50°C for 30 min	13.0	(21.1)
T_{17}: Hot water treatment at 60°C for 10 min	7.5	(15.3)
T_{18}: Hot water treatment at 60°C for 20 min	6.0	(14.2)
T_{19}: Hot water treatment at 60°C for 30 min	9.0	(17.5)
T_{20}: Hot water treatment at 70°C for 10 min	11.5	(19.4)
T_{21}: Hot water treatment at 70°C for 20 min	10.0	(18.4)
T_{22}: Hot water treatment at 70°C for 30 min	12.0	(20.3)
T_{23} : Control (treating with normal water)	15.5	(22.8)
CD (0.05)	12.07	
CV%	9.34	

In the standing crop of paddy, *Vicia* can not germinate due to dormancy. It can germinate only after the removal of paddy sheaves in rice fallows. Only 15 to 20 per cent germination was observed with fresh seed and the germination percentage improves with the ageing of the seeds. Very high percentage of dormant seed was observed in *Vicia sativa* weed. Information on breaking dormancy of common vetches (*Vicia* spp.) is scanty. Hence, breaking seed dormancy of *Vicia sativa* by different methods was studied.

The seed of *Vicia sativa* were subjected to different physico-chemical treatments (Table) for breaking seed dormancy in the laboratory of Weed Science Division, Agricultural College, Bapatla, Andhra Pradesh during 1999-2000. Completely randomized block design was adopted with 23 treatments replicated thrice.

The data on germination percentage of various treatments are presented in Table. The results indicated that acid scarfication with concentrated H_2SO_4 for 15 min and 17 min recorded highest germination of 93 per cent (74.7) than all the other treatments imposed. Aswathaiah and Delouche (1987) also reported 20 min treatment with concentrated H_2SO_4 was found to be most effective in reducing hard seed content without any appreciable loss in total viability of Vetch seeds (*Vicia* spp). There was no significant difference observed among the acid treatments from 7 min to 17 min. No significant difference was observed in germination among the hot water and normal water treatments. Rubbing with sand paper recorded 45.5 per cent (42.1) germination which was significantly lower than acid treatment with 5 min and significantly higher when compared to hot water and normal water (control) treatments.

Hence, the present study indicated that acid treatment with concentrated of H_2SO_4 for 7 min was needed for breaking seed dormancy of *Vicia sativa*. Seed coat and hilum .are involved in changing impermeability to permeable condition of the seed in common vetches (*Vicia* spp.) (Aswathaiah, 1984).

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Research Note

Morphological Parameters and Total Biomass of Groundnut as Influenced by Teak Based Agro-forestry System

Key Words: Agro-forestry, Teak, Subabul, Grass, Groundnut

Agro-forestry has generated high levels of enthusiasm in recent years among researchers, developmental experts and policy planners concerned with land use systems. Although, it is true that the scientific principles of agro-forestry are only new being examined and understood, the practice in some form or the other has been in existence since very early times, especially among the farmers in the warmer parts of the world (Nair, 1984).

Mutanal (1998) reported a significant decrease in plant height and leaf area of groundnut when grown in teak based agro-forestry systems. However, not much research work has been done on the combination of trees and annual crops, especially under rainfed conditions. The reason for this paucity of information appears to be the dominance of entrenched notion that trees and annual crops are mutually incompatible (Nadagoud, 1990). Hence, the present study was conducted to study the influence of teak based agro-forestry systems on the morphological parameters and total biomass of groundnut.

The field experiment was conducted to study the effect of different teak based agro-forestry systems on morphological parameters and total biomass of groundnut yield during *kharif* 2004 at Main Agricultural Research Station, Dharwad. The soil of the experimental field was red gravelly with 38.5 per cent coarse sand, 29.6 per cent fine sand, 15.2 per cent silt and 16.7 per cent clay. The pH and EC were 5.92 and 0.52 dSm^{-1} respectively. the experiment was laid out in a split – spilt plot design with 4 replications and 16 treatments. the treatments comprised different agro-forestry systems (AFS), directions (DR) from teak row and distance (DS) from teak row. Teak was planted during the year 1984 at 10 m and 20 m alleys (2 m intra- row spacing). Along the teak row, on either side of teak alleys, grass slips (or) subabul seedlings were planted at 60 cm between rows and 60 cm between 2 plants for grass and 20 cm for subabul. Both grass and subabul were harvested for fodder purpose and served as live bund to prevent runoff of rainwater. The observations were made upto 5 m on either side of 20 m teak alley to facilitate uniformity with 10 m teak alley.

Plant height (cm), number of leaves per plant, number of branches per plant and leaf area (dm^2 plant^{-1}) (Table 1) was significantly higher in sole groundnut as compared to groundnut grown with teak based agro-forestry systems. These parameters recorded higher values on western side of teak row as compared to eastern side and also these values increased with increase in distance from teak row.

In the present study, the plant height was maximum in sole groundnut. Lowest plant height was recorded when groundnut was grown with teak + subabul followed by teak and teak + grass, the reason that can be attributed to this is the moisture stress. Cell turgidity might have been reduced due to water stress, thereby decreasing the cell elongation and thus the reduced elongation of stem resulting in shorter plants. The observation in the present study is in line with the observation of Kramer (1959) who observed reduced cell elongation due to reduced cell turgidity which decreased not only the size of the platns but also the yield.

The number of leaves was influenced to a greater extent by pasture and forage components. Sole groundnut treatment recorded maximum number of leaves per plant. At 0-1 m and 4-5 m distances, number of leaves per palnt was lowest when groundnut was grown with teak, followed by teak + subabul and teak + grass. Number of leaves per plant increased from the tree base. This decrease in number of leaves as compared to sole groundnut can be attributed to the moisture stress created due to the competition between the tree species and crop and may also be due to the solar energy. Since sole groundnut had a competition free environment, it had highest number of leaves.

Table 1 : Plant height (cm), number of leaves and branches per plant, leaf area (dm^2 plant^1) of groundnut as influenced by agroforestry system, direction and distance.

Experimental Details	Plant height (cm)				No. of leaves per plant				No. of branches per plant				Leaf area (dm^2 plant^{-1})			
	30 DAS	50 DAS	70 DAS	Harvest	30 DAS	50 DAS	70 DAS	Harvest	30 DAS	50 DAS	70 DAS	Harvest	30 DAS	50 DAS	70 DAS	Harvest
AFS																
1. GN	17.5	23.6	26.4	32.3	30.97	100.82	116.17	21.95	4.17	5.42	6.07	6.60	2.42	8.78	10.16	3.44
2. GN+T	13.8	18.1	21.5	29.3	22.02	60.62	66.55	15.56	2.58	3.84	4.48	5.01	1.81	3.87	4.33	1.64
3. GN+T+G	15.1	17.7	20.9	31.5	16.07	67.3	73.3	21.77	2.23	3.49	4.13	4.66	1.69	3.66	4.04	2.2
4. GN+T+S	14.1	17.9	21.0	29.1	19.67	61.6	68.05	16.2	2.44	3.7	4.34	4.87	1.47	3.82	4.27	1.72
CD@5%	0.25	0.17	0.07	0.06	0.31	0.3	0.17	0.1	0.09	0.07	0.12	0.07	0.08	0.07	0.06	0.07
Direction																
1. Eastern	14.3	18.8	21.9	30.7	19.92	71.07	79.18	18.24	2.68	3.94	4.58	5.11	1.65	4.82	5.47	2.08
2. Western	15.9	19.8	22.9	30.5	24.45	74.1	82.8	19.5	3.03	4.29	4.93	5.46	2.05	5.24	5.93	2.42
CD @ 5%	NS	0.11	0.04	0.03	0.16	0.27	0.11	0.12	0.06	0.07	0.06	0.04	0.04	0.05	0.03	0.04
Distance																
1. 0-1 m	12.1	14.4	17.1	28.2	14.77	55.76	58.77	13.56	2.22	3.48	4.12	4.65	1.36	3.45	3.81	1.32
2. 4-5 m	18.1	24.3	27.8	32.9	29.6	89.51	103.21	24.17	3.49	4.74	5.39	5.92	2.34	6.61	7.59	3.18
CD @ 5%	0.23	0.15	0.03	0.04	0.16	0.29	0.15	0.14	0.07	0.05	0.05	0.03	0.04	0.04	0.04	0.05
interactions																
AFS.DR	0.46	0.23	0.1	0.08	0.38	0.49	0.23	0.2	0.13	0.12	0.15	0.09	0.1	0.1	0.08	0.09
AFS.DS	0.45	NS	0.07	0.07	0.34	0.58	NS	0.29	0.15	0.11	0.1	0.07	0.07	0.08	0.07	0.11
DR.DS	0.43	0.25	0.06	0.07	0.3	0.51	0.25	NS	NS	NS	NS	0.06	0.07	0.07	0.07	0.09
AFS.DR.DS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

AFS - Agroforestry system DR - Direction DS - Distance GN - Groundnut T - Teak G - Guinea grass S - Subabul

Leaf area was significantly higher under sole groundnut. It was significantly lower when groundnut was grown with teak + grass at 0-1 m and 4-5 m distances followed by teak + subabul and teak. More moisture depletion at 0-1 m and 4-5 m distance under teak + grass was the main cause for reduction in leaf area per plant. Since the competition for the moisture, nutrient and the solar radiation was low with teak, the leaf area produced was higher when groundnut was grown with teak. Kramer (1959) reported that water stress caused decrease in enlargement of leaves due to reduced cell elongation and earlier cell maturation as these processes depend upon turgidity of cells. The reduction in leaf size is more, decreases the photosynthetic surface and finally affected the yield (Padeyannavar, 2002).

Total biomass (Table 2) was significantly higher in sole groundnut as compared to groundnut grown with teak based agro-forestry system. Total biomass was significantly higher on western side of teak growth as compared to eastern side. It also increased with increase in distance from teak row. Not only the leaf number, but also the number of branches and leaf area per plant which affects the dry matter produced per plant. The moisture stress throughout the crop growth resulted in premature closure of stomata to reduce water loss. But it also decreased carbon dioxide diffusion into the leaves there by affecting photosynthesis. Moisture stress also caused dehydration of protoplasm again causing reduction in photosynthetic rate which in turn resulted in reduction of yield.

Table 2 : Total biomass (g plant^{-1}) of groundnut as influenced by agroforestry system, direction and distance at different growth stages.

DR/DS	Agroforestry system																			
	30 DAS					50 DAS					70 DAS					Harvest				
	GN	GN+T	GN+T+G	GN+T+ Sb	Mean	GN	GN+T	GN+T+G	GN+T+ Sb	Mean	GN	GN+T	GN+T+G	GN+T+ Sb	Mean	GN	GN+T	GN+T+G	GN+T+ Sb	Mean
DR-E																				
DS 0-1	1.97	0.67	0.66	0.69	0.99	10.43	2.77	2.74	2.77	4.67	18.34	4.73	5.43	4.80	8.32	40.14	11.14	12.44	9.94	18.41
DS 4-5	2.24	2.07	1.86	1.92	2.02	10.56	7.02	7.47	7.72	8.19	18.06	12.75	12.16	13.32	14.07	42.24	30.04	29.34	30.44	33.01
Mean	2.10	1.37	1.26	1.30	1.51	10.49	4.89	5.10	5.24	6.43	18.20	8.74	8.79	9.06	11.19	41.19	20.59	20.89	20.19	25.71
DR w																				
DS 0-1	2.26	0.94	0.99	1.08	1.31	10.32	2.95	3.13	3.00	4.85	18.27	5.53	5.48	5.29	8.64	39.14	13.54	14.74	11.84	19.81
DS 4-5	2.14	2.71	2.11	2.53	2.37	10.34	7.11	7.71	8.07	8.30	18.21	13.58	13.32	13.99	14.77	40.94	33.34	33.24	34.84	35.59
Mean	2.20	1.82	1.55	1.80	1.84	10.33	5.03	5.42	5.33	6.57	18.24	9.55	9.40	9.64	11.70	40.04	23.44	23.99	23.34	27.70
DS																				
DS 0-1	2.11	0.80	0.82	0.88	1.15	10.37	2.86	2.93	2.88	4.76	18.30	5.13	5.45	5.04	8.48	39.64	12.34	13.59	10.89	19.11
DS 4-5	2.19	2.39	1.98	2.22	2.19	10.45	7.06	7.59	7.89	8.25	18.13	13.16	12.74	13.65	14.42	41.59	31.69	31.29	32.64	34.30
Mean for AFS	2.15	1.59	1.40	1.55	1.67	10.41	4.96	5.26	5.39	6.50	18.22	9.14	9.09	9.35	11.45	40.61	22.01	22.44	21.76	26.70
CD @ 5%																				
AFS			0.08					0.04					0.03					0.39		
DR			0.07					0.05					0.05					0.20		
DS			0.06					0.03					0.03					0.16		
AFS-DR			0.13					0.08					0.08					0.49		
AFS-DS			0.12					0.07					0.05					0.31		
DR-DS			NS					NS					0.06					0.31		
AFS-DR-DS			NS					NS					NS					NS		

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